

ALAGAPPA UNIVERSITY

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DIRECTORATE OF DISTANCE EDUCATION

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MBA/LM

MBA (PRODUCTION AND OPERATIONS MANAGEMENT)

PAPER- 4.3 4.1

WAREHOUSING MANAGEMENT

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MBA (PRODUCTION AND OPERATIONS MANAGEMENT)

Paper – 4.3

Self Learning Material



DIRECTORATE OF DISTANCE EDUCATION
ALAGAPPA UNIVERSITY
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TAMILNADU

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1.0 INTRODUCTION

Case Study: Supply Chain Management of Walmart

The world's largest retailer Walmart was founded by Sam Walton in the year 1962. He opened his first store in Rogers, Ark. On 31st October 1969, the company was incorporated as Walmart stores. The key success factor was the guidance of Sam. Presently they are operating in 15 countries with more than 8,000 stores with 2.1 million employees (2009). Major features of Walmart stores are its store area, cleanliness and its shelves which are filled with varieties of quality items that includes healthcare products, family apparels, electronic items, automotive products, hardware items, jewellery etc.

Walmart is giving more emphasis for customer needs and tried to reduce cost through the effective usage of supply chain management system. In the year 2009, Fortune Magazine ranked Walmart as first among other retailers in its survey. Sales were about 401 billion U S dollars in the FY 2009. Sam Walton claims that Walmart's vision had always been to increase sales through lowering the costs through organized distribution system with the help of the Information Technology. It is said that Walmart's extreme success could be attributed to its effective supply chain management.

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Walmart's efficiency in supply chain management was due to two key factors namely automated distribution center and the computerized inventory system. This brought in minimizing a lot of time which not only reduced the checking out time but also recorded the transaction which is much needed to know the demand. Demand forecast is a constant issue which could be a threat when not handled properly. This is due to the fact that demand prediction is always inaccurate. Aggregation would be a remedy for this unpredictable demand.

Walmart's focus has always been to sell goods at a lower price to the customers. They ensured direct purchase from the companies bypassing the intermediaries. This by-passing is one of the ways to reduce cost. Walmart preferred small vendors to the big players, however, the vendor who provides the best price, qualifies and gets the deal. This applies to the giants like P& G as well. Their practice these days had been choosing few vendors and they literally negotiate the best price, the one that comes up with the best price qualifies. This does not blindly mean that they have been ruthless. Walmart also work with the vendors for improving its supply chain efficiency.

Walmart with its power distribution system made quite innovative changes like reducing paper work, reduced its lead time drastically, used bar codes to bill which recorded inventory levels and the access to the stock levels served as the valuable data for management. The movements of products are systematic and strategically aligned in a way that it reduces the most valuable time and cost and results in efficiency. Walmart had a very effective, rather responsive and flexible distribution system to transport goods from docks to stores. It educated the drivers with the ethics and code of conduct which pictures their supply chain responsibility. Cross docking is one lethal weapon that was used by Walmart in their SCM.

Cross docking is a method of handling goods. This happens when the vendor and the company work together. This is the method of supplying the product in the right time and the said quantity. This cut down a lot of time. This also changed Walmart's way of looking at things. This transitioned Walmart from being a centralized management to an almost decentralized system and took a major turn in the focus of a pull strategy.

Cross docking is one of the techniques used by Walmart. It means there is no unnecessary storage or little storage in between the loading and unloading of goods so that the customer can enjoy the quality of the goods. Walmart has logistics infrastructure which is a very fast transportation system wherein the distribution centers are being serviced. Walmart assured that their drivers are capable of doing their jobs accordingly and do not cause unnecessary delays that can hamper the efficiency of the distribution operations. To deliver it on time, the coordinators give information to the driver about the expected time of arrival or delivery of the goods.

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Point of Sale: Information sharing is one of the most important things when it comes to SCM. P&G with its Pampers requested Walmart to share its point of sale so that it could predict its demand more or less and work on the information to bring in efficiency. When Walmart shared this information P&G could plan in advance and with its efficient supply chain management could supply pampers to Walmart on time.

Walmart did not want to dedicate lot of space to pamper in its warehouse. Instead the supply was taken care of by P& G. This led the initiation of working with the vendors and coming out with huge efficiency by maintaining lower inventory and satisfying demand without stock outs. Thus point of sale sharing would be a key element for any company for its further scope of improvement and also when there is further scope of improvement there is a role for supply chain management.

Source: *Scribd.com*

Warehouse management is an important function of a supply chain management. The unit discussed about the basic concepts and functions of warehouse management. The unit also discussed about the key problems and issues in receiving processes. The term warehouse is used to define a location where the inventory is stored. The key inventory items include products that a business sells or manufacturers and in many cases can include materials and tools that are used in production processes. When a business has a warehouse management system, that business has implemented a workflow or set of steps that must be taken when inventory items are received, shipped, or deployed to other locations. This system can also be used to track the count and health of various items, thereby allowing warehouse managers to determine when to restock, repair, and replace items.

Warehouse is an important part of supply chain management. The supply chain includes all the stages a product passes through, starting from production and ending in introduction into a market. There are a number of factors that affect the effectiveness of a warehouse management system such as speed of production, levels of demand, and pricing.

An inventory or warehouse manager generally is responsible for designing and optimizing a warehouse management system. He or she may be responsible for keeping up with new trends in technology that can improve efficiency of a system. A manager also might monitor areas where cost can be cut and determine solutions for improvement.

It is common for a manager to incorporate asset tracking technology into a warehouse management system. Some of the most common types of asset tracking systems involve the scanning of barcodes or the reading of Radio Frequency Identification (RFID) tags. Each of these technologies allow warehouse workers to scan inventory items to read information about items on a computer monitor, such as date received, user notes, and contract information when the scanned items are leased.

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This kind of warehouse management system requires use of a primary database. Information regarding all items in a warehouse are stored in a database. Most warehouses include a number of employees and workstations. Larger businesses might need several warehouses that communicate with one another. For these reasons, a database normally is part of a Local Area Network (LAN). A LAN describes the servers, workstations, printers, and all other computer-related components that interact in day-to-day operations in a contained geographical location.

To create an efficient warehouse management system, a manager may decide how asset tracking technology is used. He or she can be responsible for determining which information belongs in a database and which style of notation employees should use when updating files. Managers periodically train and assess workers in using a system.

1.1 UNIT OBJECTIVES

After going through this unit, you will be able to:

- Explain the meaning and importance of warehousing
- Describe the key functions of warehousing
- Discuss the concept of handling, transportation and storage of ISO containers
- State the utility and advantages of warehouses
- Identify the problems and issues in receiving processes.

1.2 MEANING OF WAREHOUSE

Warehouse is a storage structure constructed for the protection of the quality and quantity of the stored produce. The need for a warehouse arises due to the time gap between production and consumption of products. Warehousing or storage refers to the holding and preservation of goods until they are despatched to the consumers. By bridging this gap, storage creates time utility. It involves providing facilities for preservation of goods in proper condition so as to prevent loss or damage, and making the goods available to traders or dealers for sale. Warehouses are places where storage facility exists. Thus, warehousing is an essential aid to trade or ancillary of trading activity. It creates both time and place utilities, as goods stored in warehouses can be available whenever and wherever needed by buyers. Manufacturers, wholesalers as well as dealers can make use of warehousing facilities to bridge the gap between the time when goods are procured or manufactured and the time they are demanded by customers. The warehousing also arises, from the modern systems of production and distribution of goods. Large-scale production generally takes place in anticipation of demand for goods, but not necessarily in response to specific orders of customers.

SYLLABUS

MBA (Production and Operations Management)

4.3: WAREHOUSING MANAGEMENT

Unit-1: Warehouse Functions: Meaning of Warehousing - Importance – Functions: Receiving: Logistics support for Inward Transportation, Unloading, Inspection, Acceptance and Recording; Storing: Space allocation, Facilitation to stocking, Guarding & Recording; Risk bearing- Processing- Grading and branding – Disinfecting services -Issuing: Order preparation, Picking, Dispatching/ Delivery & Recording- Handling, Transportation & Storage of ISO Containers– Utility and Advantages of warehouses- Problems and issues in receiving processes.

Unit-2: Warehouse Types: Own Warehouses- Hired Warehouses- Private Warehouses- Public Warehouses- Government Warehouses- Bonded Warehouses- Co-operative Warehouses- Distribution Warehouses- Fulfillment/ Consolidation Warehouses- Warehouses Providing Value Added Services- Cross Docking and Trans-loading Warehouses- Break Bulk Warehouses- Storage Warehouses- Refrigerated Warehouses- Characteristics of ideal warehouses- Warehouse Layout- Principles and Facilities- Types.

Unit-3: Internal Operations: Measures and metrics of warehouse operations- Logistics in the warehouse- Localization of materials in a warehouse- Identification and classification of Materials and products in the warehouse- Managing the material/products turns in warehouse (FIFO/LIFO) - Problems and issues in shipment processes.

Unit-4: Warehousing Equipment: Material Handling equipment and Systems – Role of Material Handling in Logistics- Unloading and loading equipment- Rolling Ladders-Lifting equipment- Carrying equipment - Platform Trucks-Industrial Carts- Industrial Scales- Pallet Equipment - Pallet Trucks - Rack Systems- Safety Matting, Industrial Safety Equipment- Storage types and storage unit management- Material Storage Systems – principles – benefits – methods- Industrial Shelving, Industrial Storage Bins - Industrial Storage Cabinets - Spill Containment Systems-Industrial Waste Disposal.

Unit-5: Inventory Management: Inventory Management- Need and functions- Stock Levels under Conditions of Certainty, Risk and Uncertainty- Cost of carrying or not holding adequate inventory- EOQ- Stock-out cost based inventory decisions- Inventory Classification: ABC, VED and FSN- Methods of Inventory Issue Pricing- Cost and Profit implications- Inventory Ledger- Goods Receipt processing with inbound delivery/without inbound delivery - Goods issue with outbound delivery/internal consumption- Stock transfer Scenarios.

Unit-6: IT for Warehouse Management (WM): Warehouse documentation- Information flows in the warehouse- ERP-WMS - Bar code – RFID- Organization Data- Warehouse Structure- Warehouse Master Data - WM Material master view- Organization Data- Define Warehouse structure- Warehouse number - Storage type- Storage section - Storage Bin - Picking Area - Storage unit – Quantity- Creating Transfer requirement automatically/ manually - Creating Transfer requirement for storage

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Such goods cannot be sold immediately after production. The manufacturers thus need adequate facilities for storage of their products to meet the demand schedule of customers.

There is a need for storing the goods so as to make them available to buyers as and when required. Storage enables a firm to carry on production in anticipation of demand in future. Warehouses enable the businessmen to carry on production throughout the year and sell their products, whenever there is adequate demand. Need for warehouses arise also because some goods are produced only in a particular season but are demanded throughout the year. Similarly, certain products are produced throughout the year but demanded only during a particular season.

Types of Warehouses

- **Private Warehouses:** These warehouses are owned and operated by big manufacturers and merchants to fulfil their own storage needs. Big business firms need large storage capacity on a regular basis and can afford money, construction and maintain their private warehouses. A big manufacturer or wholesaler may have a network of his own warehouses in different parts of the country. The private warehouses are licensed to private persons and only the goods imported by or on behalf of the licensee are stored in such warehouses.
- **Public Warehouses:** These warehouses are a specialised business establishment that provides storage facilities to the general public for a certain charge. It may be owned and operated by an individual or a cooperative society. It works under a licence from the Government. They are generally located near the junctions of railways, highways and waterways. They therefore, provide excellent facilities for the easy receipt, dispatch, loading and unloading of goods. They are very important in the marketing of agricultural products. A public warehouse is also known as 'duty paid warehouse'.

  Public warehouses are very useful to the business community as they can meet their storage needs easily and economically by making use of the public warehouse, without heavy investment. Such warehouses provide storage facilities to small manufacturers and traders at low costs. They provide facilities for the inspection of goods by prospective buyers. They also permit packaging and grading of goods. The public warehouses receipts are good collateral securities for borrowings.
- **Bonded Warehouses:** These warehouses are licenced by the Government to accept imported goods for storage until the payment of customs duty. They are located near the ports. They are either operated by the Government or work under the control of customs authorities. The warehouse is required to give an undertaking or 'Bond' that it will not allow the goods to be removed without the consent of the custom authorities. The goods are held in bond and cannot be withdrawn without paying the customs duty. Such warehouses are very helpful to importers and exporters. If an importer is unable to pay customs

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duty immediately after the arrival of goods he can store the goods in a bonded warehouse. He can withdraw the goods in installments by paying the customs duty proportionately. Goods lying in a bonded warehouse can be packaged, graded and branded for the purpose of sale. Central Warehousing Corporation operates 75 Custom Bonded Warehouses with a total operated capacity of nearly 0.5 million Mts.

1.3 IMPORTANCE OF WAREHOUSE

The following points explain the importance of warehousing:

- Warehouses enable storage of goods when their supply exceeds demand and by releasing them when the demand is more than immediate production. This on one hand ensures a regular supply of goods in the market and on the other hand it helps to stabilize prices by matching supply with demand.
- Warehouses provide for safe custody of goods. Businessmen can thus minimize the risks to goods from loss, damage, fire, theft etc. Perishable products can be preserved in cold storage. Also, the goods kept in a warehouse are generally insured.
- A warehouse provides facilities for processing, packing, blending, grading etc, of the goods for the purpose of sale. The prospective buyers can inspect the goods kept in a warehouse.
- Warehouses provide a receipt to the owner of goods for the goods kept in the warehouse. The owner can borrow money against the security of goods by making an endorsement on the warehouse receipt.

1.4 FUNCTIONS OF WAREHOUSE

Warehousing is a key component of the overall business supply chain. The supply chain consists of the facilities and distribution options for the procurement of materials from manufacturer to customer and all points in between. It includes the production of materials into components and finished products and then the distribution to customers.

The warehousing functionality today is much more than the traditional function of storage. The following are main function that warehousing serves today:

- Receiving goods – receive and accept responsibility by updating records.
- Identifying goods – place, label, colour code (normal stocks, promotional stocks, special customer stocks like CSD, price changes, batch etc). sorting goods- sort out the received goods based on identification for appropriate storage area. For example special customer goods, revised price goods, promotional goods should be sorted out separately. Dispatching/ put away the sorted goods in an appropriate storage place — for temporary storage with easy accessibility.

- Holding goods — security against pilferage and deterioration.
- Selecting, retrieving, packing — items are retrieved and grouped according to customer order for dispatch.
- Marshaling goods — check the items of a single order for completeness and order records are updated. Dispatching goods- consolidated order is packaged and directed to right transport.
- Preparing records — of stocks and replenishment requirements.

The following sub-sections provide a detailed discussion on warehousing functions.

1.4.1 Receiving of Inventory

The first and most important function of a warehouse is to receive the inventory. It is very important for a warehouse manager to make proper inspection and recording of the receiving inventory. While receiving of goods the following points should be considered:

1. Logistics Support for Inward Transportation

Inward transport or traffic moves materials from suppliers to an organization's receiving area. For this, managers have to choose the type of transport (road, rail, air, etc.), find the best transport operator, design a route, make sure that all safety and legal requirements are met, ensure deliveries on time, and keep costs low, and so on. The following are the key mode of transportation:

(a) Road Transport

Large producers and dealers of goods often use their own motor trucks, delivery vans and other vehicles for inward and outward transport of goods. There are also public transport agencies which operate trucks and vans on hire. Vehicles owned by producers and dealers are put to use, whenever required. A separate department is generally entrusted with the task of proper maintenance of the vehicles and regulating their movement. Hired vehicles are generally used on a contract basis for regular purposes. Alternatively vehicles are hired from agencies as and when required. A truck service can also be arranged for less then full truck load. Before they are loaded into the vehicle, goods are required to be packed in crates or wooden cases or in bales or any other form depending on the nature of the product. However, packing may not be needed in the case of goods like iron rods, beams, bricks, sand, stone chips, minerals, coal, etc., which are carried in bulk. Motor vehicles are also specially made known as tankers, for carrying liquids in bulk.

(b) Rail Transport

In terms of carrying capacity over long distances, rail transport is unequaled by any other mode of land transport. In India railways are controlled by the Government of India.

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(c) Sea Transport

Water transport in general may be classified as: (1) river and canal transport by boats and steamers i.e. inland waterways, and (2) sea or ocean transport by ships. In the case of inland water transport, loading and unloading of goods can be arranged by setting up private jetties on the route. For instance, transport of jute takes place along the Hooghly River for jute mills in the Calcutta industrial area. The cost of transport is relatively lower than road or rail transport. However, it is a slow moving means of transport. Natural calamities like rains, floods and droughts make inland water transport unreliable. Its limited use is due to the limited areas served by waterways. Transportation by sea and ocean is most useful in coastal areas and for international trade. Rail and road connections do not exist between many countries and sea transport is the only means for imports and exports. For overseas transport, two types of vessels are available: (1) Liners which undertake regular voyages between ports according to a fixed schedule and itinerary, and (2) Tramps which do not have any fixed schedule or itinerary of voyages, but move from port to port and undertake transportation of goods as per agreement with the shippers.

(d) Air Transport

Though air transportation is largely used for passenger traffic, its importance as a mode of transport for goods is no less. Its use has considerably increased as a result of the large cargo planes. Besides, certain categories of goods like perishable items, costly goods of light weight as well as sensitive electronic goods and ready made garments are now transported by air. For sending goods by airways, the consignor has to prepare an air Consignment Note which is a document containing particulars such as the number of packages, method of packing, marks on the packages, weight, quantity, volume, freight to be paid, party to pay, value of the goods, make and address of the consignor and the consignee, the place of departure and destination, etc. The Air Consignment Note has to be prepared in three parts. One part is signed by the consignor and marked 'For the Carrier'. The second part is signed by the airways and the consignor and marked 'For the Consignor'. The third part is signed by the airways as an acknowledgement of the goods received for carriage. This is forwarded to the consignee who is to receive delivery of the goods at the destination.

2. Unloading

When the products arrive, they may be in plastic containers, cardboard cartons, wooden crates or other packaging. Some merchandise may be on hangers, other items may be on pallets. Keep in mind that a receiving area is designed to receive, not warehouse merchandise.

Large shipments should be sorted as the cartons are unloaded. Having similar merchandise grouped together will make the remaining processes of receiving merchandise much easier.

3. Inspection

Once the shipment has been accepted, the next step of processing freight is inspection in the merchandise. Some vendors may mail an invoice separately from

the shipment. A packing list is often included with the goods. The two documents may look similar but wholesale product prices and shipping costs are generally excluded from packing lists. Many retailers opt to continue the checking in process only after the invoice has arrived.

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Start the process of checking freight by comparing the vendors invoice against the store's purchase order to ensure:

- Prices and additional terms of sale are as agreed upon
- Quantities received by the retailer match purchase order
- Product styles, colours, sizes received are identical to purchase order
- Merchandise quality equals, or exceeds, the buyer's expectations

Problems and discrepancies should be documented and reported to the proper party responsible. Cartons missing or damaged in transit become the responsibility of the freight carrier or transport company. Vendors and manufacturers should be notified if the order is of poor quality, incorrect quantities, missing or wrong merchandise. Be sure to obtain a resolution to any problems before continuing to the next process of receiving freight.

4. Acceptance and Recording

Another important function of warehouse management is to the acceptance of goods and making proper recording in the books. It is important to make proper inspection of the goods before giving the material acceptance.

1.4.2 Storing

Warehousing or stores moves materials from the receiving area into storage and makes sure that they are available when needed. Warehousing also looks after stored materials, giving the right conditions, treatment and packaging to keep them in good condition. This is particularly important with, say, frozen food, drugs, alcohol in bond, chemicals, animals, and dangerous goods.

The following are the important points to remember in storing the inventory:

1. Space Allocation

Space may be a scarce resource in such storage systems as stock rooms in manufacturing shops, warehouses, freight terminals, and container terminals. Popular design issues for the storage systems are to determine the number of storage locations to be provided, the method of storing/retrieving products, and the assignment of items to locations (Francis el al., 1992).A storage activity is defined as a temporary stay of an inventory at a storage location, which comes from a source process and is bound for a destination process. Source processes include an arrival of an inventory from the outside of storage areas or a preceding process for a Work-In-Progress (WIP). Similarly, destination processes include a departure of an inventory to the outside of storage areas or a succeeding process of a WIP. Between the arrival and the departure of the inventory, it is stored at a storage location for a certain length of time. A zone of a storage area may be reserved in advance for a specific type of inventories before the inventories actually start to arrive at the storage area, in which case the starting

time of the storage activity is the moment of the reservation. The finishing time of a storage activity is the moment when the storage spaces, which have been occupied by the storage activity, are released.

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A storage activity includes several sub-activities. There are four kinds of sub-activities: arrival, stay, relocation, and departure. After an inventory is delivered from the location of the preceding process of the inventory to the storage area (arrival), it is stored there during a certain number of periods (stay). During the stay, it may be relocated from a storage position to another (relocation). Finally, it is delivered to the next process of the inventory (departure).

We propose the following assumptions to define a storage activity:

- Space must be available at the beginning of the period when the corresponding inventory arrives at the storage area.
- The arrival (receiving operation) of a storage activity occurs only at the period when the corresponding inventory arrives at the storage area.
- The departure (delivery operation) of a storage activity may occur at more than one period. Space is released at the end of each period when the corresponding inventory leaves the storage area.
- A relocation of an inventory from a storage location to another starts and ends during a period.

2. Facilitation to Stocking

It refers to the use of the warehouse as a reservoir to handle production overflows. Such reservoirs are needed under two situations (i) seasonal production and level demand and (ii) level production and seasonal demand. For example, the canner of tomato products builds a warehouse inventory at harvest time, while customer demand for the product is fairly at the same level throughout the year. Against this, in case of the toy manufacturer, the highest demand comes at certain seasons or holidays, but the manufacturer may need to stockpile in order to accommodate seasonal demand. In either case, the warehouse is the reservoir used to balance supply and demand.

3. Guarding and Recording

A warehouse provides protection to goods from loss or damage due to heat, dust, wind and moisture, etc. It makes special arrangements for different products according to their nature. It cuts down losses due to spoilage and wastage during storage.

4. Risk Bearing

Warehouses take over the risks incidental to storage of goods. Once goods are handed over to the warehouse-keeper for storage, the responsibility of these goods passes on to the warehouse-keeper. Thus, the risk of loss or damage to goods in storage is borne by the warehouse-keeper. Since it is bound to return the goods in good condition, the warehouse becomes responsible for any loss, theft or damage, etc. Thus, it takes all precautions to prevent any mishap.

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5. Processing

Certain commodities are not consumed in the form they are produced. Processing is required to make them consumable. For example, paddy is polished, timber is seasoned, and fruits are ripened, etc. Sometimes warehouses also undertake these activities on behalf of the owners.

6. Grading and Branding

On request warehouses also perform the functions of grading and branding of goods on behalf of the manufacturer, wholesaler or the importer of goods. It also provides facilities for mixing, blending and packaging of goods for the convenience of handling and sale.

7. Disinfecting Services

In some cases warehouses provide transport arrangement to the bulk depositors. It collects goods from the place of production and also sends goods to the place of delivery on request of the depositors.

1.4.3 Issuing

Within a supply chain network there is an issue not only of what materials to stock and in what quantities, but also in what locations. Options can include distribution centers devoted to specific markets or parts of the product range distribution centers dedicated to serving specific geographic areas, or regional distribution centers that hold for example the fast moving product lines, with the slower lines held only in a Regional Distribution Centre (RDC). The option depends on such factors as customer base, product range and service levels required.

1. Order Preparation

The foremost important function of issuing process of material from the warehouse is to identify the goods as per the order. The order preparation is an important issuing function.

2. Picking

Order picking finds and removes materials from stores. Typically, materials needed for a customer order are located, identified, checked, removed from racks, consolidated into a single load and moved to a departure area for loading onto delivery vehicles. Goods are selected from order picking stock in the required quantities and at the required time to meet customer orders. Picking often involves break bulk operations, when goods are received from suppliers in, say, whole pallet quantities, but ordered by customers in less than pallet quantity. Order picking is important for achieving high levels of customer service; it traditionally also takes a high proportion of the total warehouse staff complement and is expensive. The good design and management of picking systems and operations are consequently vital to effective warehouse performance.

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3. **Dispatching/Delivery and Recording**

Picked goods as per the customer order are consolidated and packed according to customer order requirement. It is shipped according to customer orders and respective destinations.

1.5 HANDLING, TRANSPORTATION AND STORAGE OF ISO CONTAINERS

ISO or intermodal containers are used for the intermodal transport of freight. They are manufactured according to specifications from the International Oragnization for Standardization (ISO) and are suitable for multiple transportation methods such as truck, rail, or ship. These regulations define a shipping container that meets size, strength, and durability requirements. The basis of these regulations is to guarantee that the container can withstand extreme environments endured during transport as well as possess the structural integrity needed to be lifted by cranes or other heavy equipment.

1.5.1 Container Safety Certificate (CSC)

ISO containers include a container safety certificate (CSC) issued by the manufacturer that must be renewed every 30 months by a certified inspector. If necessary, an approved continuous examination programme (ACEP) can be used in place of this procedure.

CSC SAFETY APPROVAL
NEXT MAINTENANCE EXAMINATION IS DUE ON (MONTH/YEAR)
DATE MANUFACTURED
IDENTIFICATION No.
MAXIMUM GROSS WEIGHT KG LBS
ALLOWABLE STACKING WEIGHT FOR 1.8 g KG LBS
RACKING TEST LOAD VALUE KG LBS

Source: *Containers for Sale*

1.5.2 Selection Criteria

When selecting an ISO container the most important criteria to consider are the type and dimensions of the container. It is also important to understand the codes used to mark and identify the container as well as features that may be available.

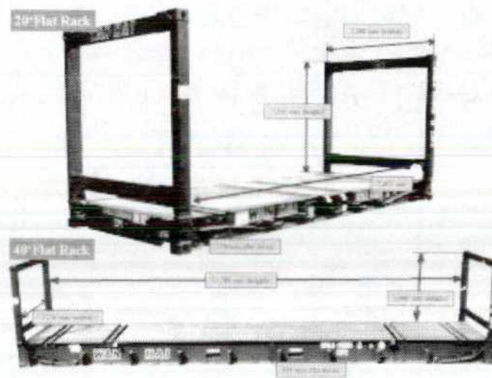
There are several basic types of ISO containers including flat racks, open-top, dry freight, insulated, reefer, and tank containers.

1. **Flat racks and platforms:** Flat racks and platforms are ISO containers that are used to transport heavy machinery. They do not have side walls, but may have end bulkheads and are often collapsible.

Check Your Progress

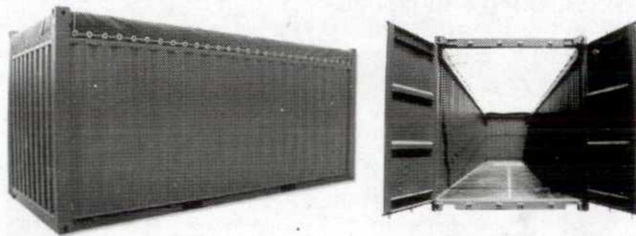
1. Define warehouse.
2. What are the bonded warehouses?
3. What do you mean by a supply chain?
4. Define warehousing.

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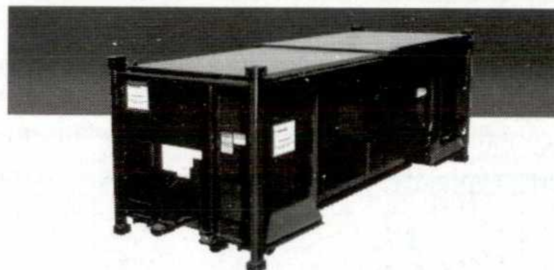
Source: *flatrackcontainer.org*

2. **Open-top containers:** Open-top containers are shaped like a box and loaded from either the top or end. They are designed to carry heavy, tall, or hard to load materials such as coal or grain.



Source: *Shipping Containers24*

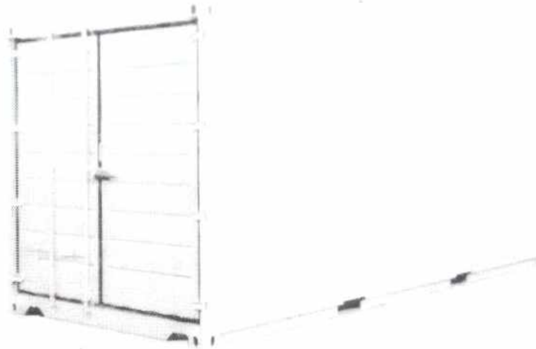
3. **Dry freight or cube containers:** Dry freight or cube containers are front loaded, completely enclosed and suitable for general purpose transportation.



Source: *BakerCorp*

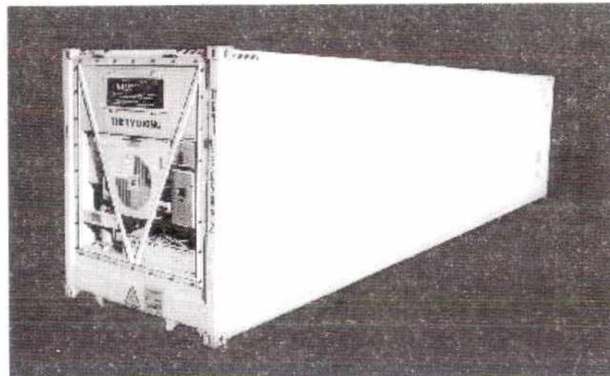
4. **Insulated or thermal containers:** Insulated or thermal containers are suitable for transporting chilled and frozen goods, as well as temperature-sensitive materials and products. They have insulated walls, but are not refrigerated.

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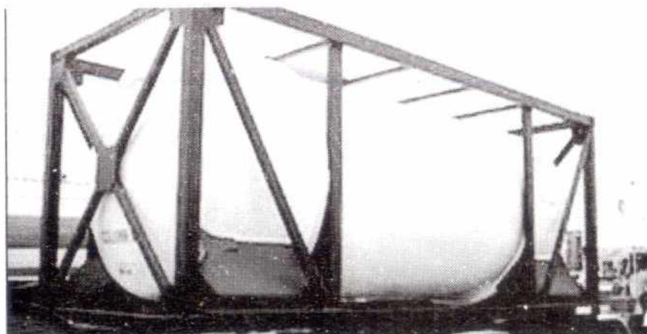
Source: *Coastal Container*

5. **Reefer or refrigeration containers:** Reefer or refrigeration containers are temperature controlled containers that have an integral refrigeration unit. They are used to ship and transport perishables or other items that require a temperature controlled atmosphere.



Source: *Cold Box*

6. **Tank containers:** Tank containers are built to the same standard dimensions as other ISO containers, but are cylindrical vessels mounted in a rectangular steel framework. Typically, these containers are used to transport liquid or bulk materials.



Source: *Tank Services Inc.*

1.5.3 Dimensions

ISO containers are the ideal shipping container as their dimensions are regulated by the International Standards Organization (ISO). These regulations allow ISO containers to use space as efficiently as possible regardless of the method of transport.

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Height

Standard ISO containers measure 8 ft. 6 in., but they are available in several discrete heights measuring from 4 ft. to 9 ft. 6 in. Containers that measure 9 ft. 6 in. tall are called extended height or high cube containers while 4 ft. and 4 ft. 6 in. containers may be referenced as half height containers.

Width

The majority of all ISO containers measure 8 ft. or 2,438 mm wide. ISO containers that exceed this dimension are grouped into two other size ranges. Alpha characters C, D, E, and F identify containers that are greater than 2,438 mm, but less than 2,500 mm. Containers that exceed 2,500 mm are referenced by L, M, N, and P.

Length

The most common lengths are 20 and 40 ft. Other lengths include 24, 28, 44, 45, 46, 53, and 56 ft.

1.5.4 Coding, Identifying, and Marking

The standard used to identify intermodal (shipping) containers is ISO 6346:1995. This standardized identification system is used to give each container a unique marking. The code can be further broken up into three parts—an ISO 6346 (BIC) code, a size and type code, and additional optional markings.



Owner Code (3 letters): UES
Product Group Code (1 letter): U
Registration Number (6 digits): 485812
Check Digit (1 digit): 5
Size & Type Code (4 digits/letters): LEG1
Operational Characteristics
Maximum Weight: 34,000 kg
Container Weight: 4,860 kg
Payload Weight: 29,140 kg
Cubic Capacity: 3,153 cubic feet

Source: *The Geography of Transport Systems*

NOTES

ISO 6346 (BIC) Codes

The ISO 6346 (BIC) code identifies the owner of the container, the product group, and contains a unique serial number and check digit that identifies the container. The company code or owner code is the first three alpha characters. This abbreviation is registered with an international organization, Bureau International des Containers et du Transport Intermodal, ensuring every company has a unique code. The product group U is used for all intermodal containers while J is used for equipment attachments and Z designates chassis or frames used to carry intermodal containers. The serial number identifies an individual container and is cross referenced with the check digit.



Source: *ShippingContainers24*

Size and Type Codes

The size and type code is a four character code that represents the length, height, width, and type of container. The first character specifies the length, the second the height and width, and the last two characters specify the type of container as shown in the table below.

Code	Group code	Type	Type code	Principal characteristics
G	GP	Unventilated general purpose container	G0	Openings at one or both ends
			G1	Vents in upper part of cargo space
			G2	Openings at one or both end(s), plus "full" openings at one or both sides

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			G3	Openings at one or both end(s), plus "partial" openings at one or both sides
			G4	Spare
			G5	Spare
			G6	Spare
			G7	Spare
			G8	Spare
			G9	Spare
V	VH	General purpose containers with ventilation	V0	Non-mechanical ventilation at the lower and upper parts of the cargo space
			V1	Spare
			V2	Mechanical ventilation installed in the container
			V3	Spare
			V4	Mechanical ventilation installed outside the container
			V5	Spare
			V6	Spare
			V7	Spare
			V8	Spare
			V9	Spare
B	BU	Dry bulk containers, non-pressure-resistant	B0	Closed
			B1	Airtight
	BK	Pressurized	B2	Spare
			B3	Horizontal discharge, test pressure 150 kPa
			B4	Horizontal discharge, test pressure 265 kPa
			B5	Tipping discharge, test pressure 150 kPa

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			B6	Tipping discharge, test pressure 265 kPa
			B7	Spare
			B8	Spare
			B9	Spare
S	SN	Named cargo containers	S0	Livestock container
			S1	Automobile container
			S2	Living fish container
			S3	Spare
			S4	Spare
			S5	Spare
			S6	Spare
			S7	Spare
			S8	Spare
			S9	Spare
R	RE	Thermal containers • refrigerated • refrigerated and heated • self-powered refrigerated/ heated	R0	Mechanically refrigerated
	RT		R1	Mechanically refrigerated and heated
	RS		R2	Mechanically refrigerated
			R3	Mechanically refrigerated and heated
			R4	Spare
			R5	Spare
			R6	Spare
			R7	Spare
			R8	Spare
			R9	Spare

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H	HR	Thermal containers • refrigerated and/or heated with removable equipment	H0	Refrigerated and/or heated with removable equipment located externally, coefficient of heat transfer K=0.4 W/(m^2.K)
			H1	Refrigerated and/or heated with removable equipment located internally
			H2	Refrigerated and/or heated with removable equipment located externally, coefficient of heat transfer K=0.7 W/(m^2.K)
			H3	Spare
			H4	Spare
	HI		H5	Insulated, coefficient of heat transfer K=0.4 W/(m^2.K)
			H6	Insulated, coefficient of heat transfer K=0.7 W/(m^2.K)
			H7	Spare
			H8	Spare
			H9	Spare
U	UT	Open-top containers	U0	Opening(s) at one or both end(s)
			U1	Opening(s) at one or both end(s) plus removable roof in end frame
			U2	Opening(s) at one or both end(s) plus opening(s) on one or both sides
			U3	Opening(s) at one or both end(s) plus opening(s) on one or both sides plus removable top members
			U4	Opening(s) at one or both end(s) plus opening(s) on one side plus full openings on the other side

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			U5	Full, solid side and end walls (no doors)
			U6	Spare
			U7	Spare
			U8	Spare
			U9	Spare
P	PL	Platform (container) • platform based on containers with incomplete superstructure • fixed • folding • platform-based containers with complete superstructure	P0	Platform
	PF		P1	Platform with two complete, fixed end walls
			P2	Platform with fixed posts, either free-standing or with removable top members
	PC		P3	Platform with folding complete end walls
			P4	Platform with folding posts, either free-standing or with removable top members
	PS		P5	Platform, open at the top and ends (skeletal)
			P6	Spare
			P7	Spare
			P8	Spare
			P9	Spare
T	TN	Tank container for non-dangerous liquids	T0	Minimum pressure 45 kPa
			T1	Minimum pressure 150 kPa

			T2	Minimum pressure 265 kPa
	TD	Tank container for dangerous liquids	T3	Minimum pressure 150 kPa
			T4	Minimum pressure 265 kPa
			T5	Minimum pressure 400 kPa
			T6	Minimum pressure 600 kPa
	TG	Tank container for gases	T7	Minimum pressure 910 kPa
			T8	Minimum pressure 2 200 kPa
			T9	Minimum pressure (yet to be assigned)
A	AS	Air/surface containers	A0	

Source: *SMDG*

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1.6 UTILITY AND ADVANTAGES OF WAREHOUSES

Warehousing offers many advantages to the business community. Whether it is industry or trade, it provides a number of benefits which are listed below.

- ***Protection and preservation of goods -*** Warehouse provides necessary facilities to the businessmen for storing their goods when they are not required for sale. It provides protection to the stocks, ensures their safety and prevents wastage. It minimises losses from breakage, deterioration in quality, spoilage etc. Warehouses usually adopt latest technologies to avoid losses, as far as possible.
- ***Regular flow of goods-*** Many commodities like rice, wheat etc. are produced during a particular season but are consumed throughout the year. Warehousing ensures regular supply of such seasonal commodities throughout the year.
- ***Continuity in production-*** Warehouse enables the manufacturers to carry on production continuously without bothering about the storage of raw materials. It helps to provide seasonal raw material without any break, for production of finished goods.
- ***Convenient location-*** Warehouses are generally located at convenient places near road, rail or waterways to facilitate movement of goods. Convenient location reduces the cost of transportation.
- ***Easy handling-*** Modern warehouses are generally fitted with mechanical appliances to handle the goods. Heavy and bulky goods can be loaded and

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unloaded by using modern machines, which reduces cost of handling such goods. Mechanical handling also minimizes wastage during loading and unloading.

- ***Useful for small businessmen-*** Construction of own warehouse requires heavy capital investment, which small businessmen cannot afford. In this situation, by paying a nominal amount as rent, they can preserve their raw materials as well as finished products in public warehouses.
- ***Creation of employment -*** Warehouses create employment opportunities both for skilled and unskilled workers in every part of the country. It is a source of income for the people, to improve their standards of living.
- ***Facilitates sale of goods-*** Various steps necessary for sale of goods such as inspection of goods by the prospective buyers, grading, branding, packaging and labelling can be carried on by the warehouses. Ownership of goods can be easily transferred to the buyer by transferring the warehouse-keeper's warrant.
- ***Availability of finance-*** Loans can be easily raised from banks and other financial institutions against the security of the warehouse-keeper's warrant. In some cases warehouses also provide advance to the depositors of goods on keeping the goods as security.
- ***Reduces risk of loss -*** Goods in warehouses are well guarded and preserved. The warehouses can economically employ security staff to avoid theft, use insecticides for preservation and provide cold storage facility for perishable items. They can install fire-fighting equipment to avoid fire. The goods stored can also be insured for compensation in case of loss.

1.7 PROBLEMS AND ISSUES IN RECEIVING PROCESSES

A warehouse goes through a standard receiving process when shipments arrive to replenish stocked inventory. The warehouse coordinator or inventory clerk has a set procedure to check all received shipments and that paperwork is handled efficiently. If the warehouse personnel encounter any receiving problems, the issues can be addressed quickly so that the correct shipment is available for customers.

The following are the key issues related to warehouse receiving:

Shipment Identification

When a delivery truck arrives at the unloading dock, the inventory clerk speaks with the driver concerning the shipment. The inventory checks her records to validate that the particular item was ordered and set for delivery. The inventory clerk signs her name on the delivery shipping notice as she accepts the shipment from the driver.

Product Count

After the shipping notice is signed, the warehouse personnel unload the crates from the truck. She counts the number of crates or boxes so the quantity matches the delivery

driver's shipping notice. Each crate is opened and an exact count of the received product is taken. Any discrepancy in the count from the invoice slip is noted so that the purchasing department can rectify the situation with the product manufacturer.

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Product Inspection

The inventory clerk checks all of the products for any damage caused during shipping. Damaged products are set aside so the manufacturer can retrieve the items and offer replacements. The delivery driver must review that there are damaged products in the shipment and initial the documentation regarding the damaged products before leaving the warehouse. Depending on the manufacturer's policy, the driver may take the products at that time to bring back replacements.

Receiving Documentation

Warehouse personnel assign inventory numbers to products before stocking the items on shelves. The inventory clerk inputs all product information into the warehouse data system. She syncs the data with all other departments requiring the information, including customer service, the sales department and accounts payable department. The inventory clerk files all written documentation such as the invoices and packing slips for auditing purposes.

Case Study of Walmart: Procurement and Distribution

Walmart alwayss emphasized the need to reduce its purchasing costs and offer the best price to its customers. The company procured goods directly from manufacturers, bypassing all intermediaries. Walmart was a tough negotiator on prices and finalized a purchase deal only when it was fully confident that the products being bought were not available elsewhere at a lower price. According to Claude Harris, one of the earliest employees, "Every buyer has to be tough. That is the job. I always told the buyers: 'You are negotiating for your customer. And your customer deserves the best prices that you can get. Don't ever feel sorry for a vendor. He always knows what he can sell, and we want his bottom price. We would tell the vendors, "Don't leave any room for a kickback because we don't do it here. And we don't want your advertising programme or delivery programme. Our truck will pick it up at your warehouse. Now what is your best price?"

Walmart spent a significant amount of time meeting vendors and understanding their cost structure. By making the process transparent, the retailer could be certain that the manufacturers were doing their best to cut down costs. Once satisfied, Walmart believed in establishing a long-term relationship with the vendor. In its attempt to drive hard bargains, Walmart did not even spare big manufacturers like Procter & Gamble (P&G). However, the company, generally, preferred local and regional vendors and suppliers. In 1998, Walmart had over 40 distribution centers located at different geographical locations in the US.

Check Your Progress

State Whether the Following Statements are True or False

5. ISO containers include a container safety certificate (CSC) issued by the manufacturer that must be renewed every 25 months by a certified inspector
6. Open-top containers are shaped like a box and loaded from either the top or end.
7. Reefer or refrigeration containers are suitable for transporting chilled and frozen goods, as well as temperature-sensitive materials and products.
8. Tank containers are built to the same standard dimensions as other ISO containers, but are cylindrical vessels mounted in a rectangular steel framework.

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Over 80,000 items were stocked in these centers. Walmart's own warehouses directly supplied 85 percent of the inventory, as compared to 50-65 percent for competitors. According to rough estimates, Walmart was able to provide replenishments within two days (on an average) against at least five days for competitors. Shipping costs for Walmart worked out to be roughly 3 percent as against 5 percent for competitors.

Each distribution center was divided into different sections on the basis of the quantity of goods received and was managed the same way for both cases and palletized goods. The inventory turnover rate was very high, about once every two weeks for most of the items. Goods meant for distribution within the US usually arrived in pallets, while imported goods arrived in re-usable boxes or cases. In some cases, suppliers delivered goods such as automotive and drug products directly to the stores. About 85% of the goods which were available at the stores passed through the distribution centers. The distribution centers ensured a steady and consistent flow of products to support the supply function. As Walmart used sophisticated barcode technology and hand-held computer systems, managing the center became easier and more economical. Every employee had an access to real time information regarding the inventory levels of all the products in the center. They had to just make two scans – one to identify the pallet, and the other to identify the location from where the stock had to be picked up. Different barcodes were used to label different products, shelves and bins in a center. The hand-held computer guided an employee with regard to the location of a particular product from a particular bin or shelf in the center. When the computer verified the bin and picked up a product, the employee confirmed whether it was the right product or not. The quantity of the product required from the center was entered into the hand-held computer by the employee and then the computer updated the information on the main server.

The hand-held computer also enabled the packaging department to get accurate information about the products to be packed. It displayed all information about the storage, packaging and shipping of a particular product thus, saving time on unnecessary paperwork. It also enabled the center supervisors to monitor their employees closely enabling them to give directions and even guide them even on the move. This enabled the company to satisfy customer needs quickly and improve the level of efficiency of the distribution center management operations. Each distribution center had facilities for maintaining personal hygiene such as shower bath and fitness centers. It also had provision for food, sleep and personal business. The distribution center could also be used for meetings and paperwork. The truck drivers of Walmart sometimes availed these facilities.

About Walmart

Walmart Stores, Inc. is the largest retailer in the world, the world's second-largest company and the nation's largest non-governmental employer. Walmart

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Stores, Inc. operates retail stores in various retailing formats in all 50 states in the United States. The company's mass merchandising operations serve its customers primarily through the operation of three segments. The Walmart Stores segment includes its discount stores, Supercenters, and Neighbourhood Markets in the United States. The Sam's club segment includes the warehouse membership clubs in the United States. The company's subsidiary, McLane Company, Inc. provides products and distribution services to retail industry and institutional foodservice customers. Walmart serves customers and members more than 200 million times per week at more than 8,416 retail units under 53 different banners in 15 countries. With fiscal year 2010 sales of $405 billion, Walmart employs more than 2.1 million associates worldwide. Nearly 75% of its stores are in the United States ("Walmart International Operations", 2004), but Walmart is expanding internationally. The Group is engaged in the operations of retail stores located in all 50 states of the United States, Argentina, Brazil, Canada, Japan, Puerto Rico and the United Kingdom, Central America, Chile, Mexico, India and China

Source: *Docstoc.com*

1.8 SUMMARY

- Warehousing or storage refers to the holding and preservation of goods until they are despatched to the consumers. By bridging this gap, storage creates time utility.
- Warehouse is an important part of supply chain management. The supply chain includes all the stages a product passes through, starting from production and ending in introduction into a market.
- Warehousing is a key component of the overall business supply chain. The supply chain consists of the facilities and distribution options for the procurement of materials from manufacturer to customer and all points in between.
- The first and most important function of a warehouse is to receive the inventory. It is very important for a warehouse manager to make proper inspection and recording of the receiving inventory.
- Warehousing or stores moves materials from the receiving area into storage and makes sure that they are available when needed.
- ISO or intermodal containers are used for the intermodal transport of freight. They are manufactured according to specifications from the International Orginization for Standardization (ISO) and are suitable for multiple transportation methods such as truck, rail, or ship.

- A warehouse goes through a standard receiving process when shipments arrive to replenish stocked inventory. The warehouse coordinator or inventory clerk has a set procedure to check all received shipments and that paperwork is handled efficiently.

1.9 KEY TERMS

- **Warehouse:** Warehouse is a storage structure constructed for the protection of the quality and quantity of the stored produce.
- **Private Warehouses:** These warehouses are owned and operated by big manufacturers and merchants to fulfil their own storage needs.
- **Public Warehouses:** These warehouses are a specialised business establishment that provides storage facilities to the general public for a certain charge.
- **Bonded Warehouses:** These warehouses are licenced by the Government to accept imported goods for storage until the payment of customs duty.

1.10 ANSWERS TO 'CHECK YOUR PROGRESS'

1. Warehouse is a storage structure constructed for the protection of the quality and quantity of the stored produce. The need for a warehouse arises due to the time gap between production and consumption of products.
2. These warehouses are licenced by the Government to accept imported goods for storage until the payment of customs duty. They are located near the ports.
3. The supply chain consists of the facilities and distribution options for the procurement of materials from manufacturer to customer and all points in between. It includes the production of materials into components and finished products and then the distribution to customers.
4. Warehousing or storage refers to the holding and preservation of goods until they are despatched to the consumers. By bridging this gap, storage creates time utility.
5. False
6. True
7. False
8. True

1.11 QUESTIONS AND EXERCISES

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Short Answer Questions

1. Define warehousing.
2. Explain the importance of warehousing.
3. What are the receiving functions of a warehouse?
4. What are the key advantages of warehouses?

Long Answer Questions

1. Define warehousing. Explain the key utilities and advantages of warehousing?
2. What are the various types of warehouses? Explain the warehousing functions.
3. Discuss the handling, transportation and storage of ISO containers.
4. Analyse the key problems and issues in receiving processes.
5. Enumerate the key points to be considered at the time of receiving of inventory.

UNIT 2 WAREHOUSE TYPES

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Structure

2.0 INTRODUCTION

Warehouses are commercial buildings that are used to store goods. They can be used by manufacturers, importers, businesses, exporters, wholesalers, customs and even the general public. They are usually large buildings with a lot of empty space inside them to be able to store goods and are normally located at areas away from the busy business districts or city centers. Some warehouses can even be located near airports, seaports or railway stations for convenient transportation and storage of goods that are transported into the area. Loading docks are common in warehouses to aid loading and unloading. A regular warehouse would also have cranes and forklift to be able to load and unload goods from vehicles as well as move them around in the warehouse. These goods are usually placed on pallets that are loaded into pallet racks. The items that are stored in warehouses can range anywhere from packing materials, raw materials and components to agricultural food items such as rice, extra products that retailers wish to keep before sending out for sale and commercial products.

Warehouses can be used by an ordinary person as well and not only business owners and exporters. If an individual feels that he needs to space in his home, he can rent space in a warehouse and store the items that he does not make use of on a regular basis but would not want to throw away. Also when moving or renovating homes, warehouses can be an ideal place to store the larger bulky items.

Warehousing plays an important role in today's society, depending on their use. When manufacturers produce more goods than they can sell, manufacturers would make use of a warehouse to store the extra goods. The reason for this is to be prepared for any unseen circumstances and any sudden rise in demand. Some manufacturers may have their own warehouse where they can store their goods, whereas some may rent space in a warehouse. Different types of warehouses can also have different functions such as providing space to store goods for a long period of time or housing the goods for a short while only before they are transported elsewhere. Many warehouses that store agricultural products also have cold storage to prevent the food items from turning bad fast.

2.1 UNIT OBJECTIVES

After going through this unit, you will be able to:

- Know the different types of warehouses
- State the characteristics of an ideal warehouse
- Prepare a warehouse layout
- Describe the principles, facilities and different types of warehouse layout.

2.2 TYPES OF WAREHOUSES

The decision on which type of warehouse to select will depend on various financial and non-financial factors. Financial factors include operational cost (cost of, running the warehouse) and capital cost (cost of setting up the warehouse). Non-financial factors include control, customer service, expertise and perceived risks. Warehouses are built in different ways to meet the special requirement for storage. Different warehouses are constructed for specific goods. While selecting the types of warehouse, one has to take into consideration the factors like the nature of goods, the quality and the climatic condition. Warehousing has now gained status as a separate business, whereby manufacturers can save a considerable amount of their capital from being spent on creating infrastructure for storage. Over a period of time, warehouses have become more complex in nature. They have diversified as per their location and nature of goods that they house. Here is a list of warehouse types.

1. Own Warehouses and Hired Warehouses

Companies planning to enter the Indian market internally debate to consider the entry option either through setting their own warehouse or appointing large distributors who can act as stockists during that market entry phase.

Both situations have positive and negative things to consider, let us consider the former case for companies planning to expand in India.

- 3PL is solution to expedite entry but if SKUs numbers are more, than service provided by third party logistic companies is not up to standard.
- Inventory carrying cost and probability to create dead inventory.
- Confidence on local new hired team.

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Pitfalls by appointing large distributor to expand the base in India are as following:

- Distributor negotiates for large geographic coverage while existing infrastructure is inadequate to serve that territory.
- One more layer added besides dealer to reach to end customer.
- Dealer expansion slows down due to conflict of interest of distributor with some dealers either in customer segments or geographical location.
- To keep inventory distributor negotiate for additional credit terms.

Past study of successful companies who have expanded in India started with hiring key sales team, appointing large distributor and in very short span of time setting their own warehouse and once the product gets established than setting own their manufacturing base.

This approach helps new entrant to fine tune product offering, shorten the learning curve and momentum, further increase by setting own warehouse which results in rapid distribution channel expansion and reaching more end customer base.

Faced with the fierce competition in the global market, each manufacturer is making every effort to develop its own competitive edge. This is especially true in the interlining industry. One of the aspects for an interlining supplier to achieve competitive edge is to lower costs while increasing efficiency. Lowering the storage cost is a means for an interlining supplier to focus on. Before making a strategically planning to lower the storage cost, for an interlining supplier it is necessary to understand the basic concept of warehouse ownership classification.

Warehouses in the manufacturing industries are generally classified by the ownership. Under this idea, warehouses can be classified as private warehouses, public warehouses and contract warehouses.

2. Private Warehouses

A private warehouse is operated by the firm owning the product. The facility (land and building) could be either owned or leased. These warehouses are owned and operated by big manufacturers and merchants to fulfil their own storage needs. Big business firms need large storage capacity on a regular basis and can afford money, construction and maintain their private warehouses. A big manufacturer or wholesaler may have a network of his own warehouses in different parts of the country. The private warehouses are licenced to private persons and only the goods imported by or on behalf of the licensee are stored in such warehouses.

It is recommended to go in for a private warehouse when the utilization of the warehouse is expected to be high so that the unit cost of warehousing would

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be low. The advantages of having a private warehouse are that the company can design the warehouse to suit its specific requirements. Also the company has a great deal of control and flexibility on the warehouse operations. The company can claim depreciation on the flexibility asset and if there is excess space the company can look at renting the space out to get some extra revenue. But the capital cost of a private warehouse is very high due to which the funds of the company could get blocked (which could be used for other profitable use). Also the operating cost per unit of goods would be high if not utilized properly.

Example: Cadbury India Ltd. takes utmost care of the storage of the raw materials. They have different provisions for storing different kinds of materials. Cadbury follows a systematic way of storing and distributing its finished goods. In all, Cadbury has 27 warehouses in India in which 17 are the major warehouses and 10 are minor warehouses Thus it has one warehouse in every state called as the carry and forwarding agents.

The Thane plant is an important plant for Cadbury, producing some of the important Cadbury products. As a result it has been provided with a large warehousing facility of around 37,500 sq.t. This facility is a two-storeyed warehouse wherein the heavy materials are stored at the ground floor and lightweight materials are stored at the first floor.

Benefits of Private Warehousing

The major benefits of private warehousing include control, flexibility, cost, and other intangible benefits. Private warehouses provide more control since the enterprise has absoiute decision-making authority over all activities and priorities in the facility. This control facilitates the ability to integrate warehouse operations with the rest of the firm's internal logistics process.

Private warehousing is usually considered less costly than public warehousing because private facility costs do not have a profit mark-up. As a result, both the fixed and variable cost components should be less. This perceived benefit, however, may be misleading since public warehouses often are more efficient or may operate at lower wage scales. It is important to develop an accurate assessment of total warehouse-related costs prior to making a decision regarding warehouse strategy.

Finally, private warehousing has some intangible benefits, particularly with respect to market presence. A private warehouse with a firm's name on it may produce customer perceptions of responsiveness and stability. This perception sometimes provides a firm with a marketing advantage over other enterprises.

3. Public Warehouses

If an enterprise does not want to own a warehouse, it can go for a public warehouse. These warehouses are specialised business establishments that provide storage facilities to the general public for a certain charge. These are warehouses whose facility can be hired by anyone. It may be owned and operated by an individual or a cooperative society. It works under a licence from the government. They are

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generally located near the junctions of railways, highways and waterways. They therefore, provide excellent facilities for the easy receipt, despatch, loading and unloading of goods. They are very important in the marketing of agricultural products. A public warehouse is also known as 'duty paid warehouse'. Public warehouses are very useful to the business community as they can meet their storage needs easily and economically by making use of the public warehouse, without heavy investment. Such warehouses provide storage facilities to small manufacturers and traders at low costs. They provide facilities for the inspection of goods by prospective buyers.

They also permit packaging and grading of goods. The public warehouses receipts are good collateral securities for borrowings. It gives marketing flexibility as the company can change the location and size depending on the market demand. As a public warehouse caters to many clients, economies of scale could be achieved which could reduce cost. Public warehouses are into the business of providing warehouse operations and hence provide expertise in the field. The different types of public warehouses are general merchandise, refrigerated, special commodity (special handling), bonded and household goods.

General merchandise warehouses are designed to handle general package commodities such as paper, small appliances, and household supplies. Refrigerated warehouses (either frozen or chilled) handle and maintain food, medical items, and chemical products with special temperature requirements. Commodity warehouses are designed to handle bulk material or items with special handling considerations, such as tyres or clothing.

Bonded warehouses are used to store goods before the taxes are paid and are used extensively in international business during exports and imports.

Example: Central Warehousing Corporation (CWC) was established as a model for scientific warehousing in the country to undertake storage and distribution of the agricultural produces. It has a chain of public warehouses with over 458 warehouses of 69.75 lakh metric tonnes capacity being managed by 15 regional offices. The warehouses of CWC provide storage and ancillary services for more than 250 groups of commodities and products and many of which call for specialized arrangements and a high degree of professional care and skill.

4. Government Warehouses

This type of warehouse is mainly located at the important sea ports and in most cases is owned by the dock authorities. The general public can also use this group of warehouse on payment of fixed charges. If a customer cannot pay the rent within the specified period or time, then the authority can recover the rent by disposing of the goods.

5. Bonded Warehouses

It is one which is licensed to accept imported goods for storage before payment of customs duties. By storing his goods in a bonded warehouse the importer gains some control without paying the duty. These warehouses are licenced by the Government to accept imported goods for storage until the payment of customs

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duty. They are located near the ports. They are either operated by the Government or work under the control of customs authorities. The warehouse is required to give an undertaking or 'Bond' that it will not allow the goods to be removed without the consent of the custom authorities. The goods are held in bond and cannot be withdrawn without paying the customs duty. Such warehouses are very helpful to importers and exporters. If an importer is unable to pay customs duty immediately after the arrival of goods he can store the goods in a bonded warehouse. He can withdraw the goods in installments by paying the customs duty proportionately. Goods lying in a bonded warehouse can be packaged, graded and branded for the purpose of sale. Central Warehousing Corporation operates 75 Custom Bonded Warehouses with a total operated capacity of nearly 0.5 million Mts. The goods in bonded warehouses are under the strict supervision of customs officers and before the owner can interfere with them, previous permission is necessary.

6. Co-operative Warehouses

These warehouses are owned, managed and controlled by co-operative societies. They provide warehousing facilities at the most economical rates to the members of their society.

7. Distribution Warehouses

These are warehouses performing distribution services on behalf of their customers. This generally requires that products be received and tracked by lot or sub-lot, with or without tracking numbers, such as pallet tags or serial numbers. Shipping is usually by the pallet or bulk unit. Handling and storage charges generally relate to the item with accessorial charges being billed by the transaction. On-going storage charges are generally billed ahead on the first of each month.

8. Fulfillment/ Consolidation Warehouses

These are warehouses where products are generally received in large quantities and shipped out in a large number of smaller mixed shipments. Such pick and pack operations require special inventory management and picking procedures. Location tracking is essential. Billing methods are generally similar to distribution warehouses.

9. Warehouses Providing Value-Added Services

These are warehouses providing a wide range of value-added services. This requires the warehouse to apply labour and, in some cases, special equipment to the customer's products, such as repackaging, further processing, or labeling. This not only changes the product but requires additional billings. Such services are generally performed along with other warehouse functions.

10. Cross Docking and Trans-loading Warehouses

These are warehouses that provide cross dock and trans-loading services. Container or railcar tracking is generally important. These services often require temporary storage with charges adjusted for free days or a grace period.

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11. Break Bulk Warehouses

These are warehouses that receive products in bulk, often by railcar, and then repackage the products based on customer requirements. In the case of containers with imported products, this generally requires the inspection and relabelling of products. Generally, special billing rules apply.

12. Storage Warehouses

These are warehouses which store products for periodic delivery to a manufacturer or distribution center. This is often associated with providing just-in-time delivery of the product to the consignee. This could be imported raw materials or items used in the manufacturing process, such as cans or sub-assemblies. Items are generally tracked by lot, with the lot often being specified for delivery. Handling, storage and accessorial charges are similar to distribution warehouses.

13. Refrigerated Warehouses

Refrigerated warehouses often require more detailed tracking of products and special billing procedures. Handling charges often involve a table of decreasing charges based on volume. Often each transaction is subject to a minimum charge. And, storage charges are generally billed based on anniversary dates.

Warehouse can be classified on the basis of the following conditions:

Table 2.1: Classification of Warehouses on Conditionality

Distribution Warehouses	Warehouses performing distribution services on behalf of their customers. This generally requires that products be received and tracked by lot or sub-lot, with or without tracking numbers, such as pallet tags or serial numbers. Shipping is usually by the pallet or bulk unit. Handling and storage charges generally relate to the item with accessorial charges being billed by the transaction. On-going storage charges are generally billed ahead on the first of each month.
Fulfilment/ Consolidation Warehouses	Warehouses where products are generally received in large quantities and shipped out in a large number of smaller mixed shipments. Such pick and pack operations require special inventory management and picking procedures. Location tracking is essential. Billing methods are generally similar to distribution warehouses.
Warehouses Providing Value-Added Services	Warehouses providing a wide range of value-added services. This requires the warehouse to apply labour and, in some cases, special equipment to the customer's products, such as repackaging, further processing, or labelling. This not only changes the product but requires additional billings. Such services are generally performed along with other warehouse functions.

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Cross Docking and Trans-loading Warehouses	Warehouses that provide cross dock and trans-loading services. Container or railcar tracking is generally important. These services often require temporary storage with charges adjusted for free days or a grace period.
Break Bulk Warehouses	Warehouses that receive products in bulk, often by railcar, and then repackage the products based on customer requirements. In the case of containers with imported products, this generally requires the inspection and re-labelling of products. Generally, special billing rules apply.
Storage Warehouses	Warehouses which store products for periodic delivery to a manufacturer or distribution center. This is often associated with providing just-in-time delivery of the product to the consignee. This could be imported raw materials or items used in the manufacturing process, such as cans or sub-assemblies. Items are generally tracked by lot, with the lot often being specified for delivery. Handling, storage and accessorial charges are similar to distribution warehouses.
Refrigerated Warehouses	Refrigerated warehouses often require more detailed tracking of product and special billing procedures. Handling charges often involve a table of decreasing charges based on volume. Often each transaction is subject to a minimum charge. And, storage charges are generally billed based on anniversary dates.

2.3 CHARACTERISTICS OF IDEAL WAREHOUSES

Any warehouse is said be an ideal warehouse if it possesses the below mentioned characteristics:

- Warehouse should be located at a convenient place near highways, railway stations, airports and seaports where goods can be loaded and unloaded easily.
- Mechanical appliances should be there for loading and unloading the goods. This reduces the wastages in handling and also minimises handling costs.
- Adequate space should be available inside the building to keep the goods in proper order.
- Warehouses meant for preservation of perishable items like fruits, vegetables, eggs and butter etc. should have cold storage facilities.
- Proper arrangement should be there to protect the goods from sunlight, rain, wind, dust, moisture and pests.
- Sufficient parking space should be there inside the premises to facilitate easy and quick loading and unloading of goods.

- Round-the-clock security arrangement should be there to avoid theft of goods.
- The building should be fitted with latest fire-fighting equipments to avoid loss of goods due to fire.

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2.4 WAREHOUSE LAYOUT

Warehouse layout is the internal design or the functional design. An efficient layout and design is very important from the point of view of its functioning which is in turn, linked to the functioning of the plant. A good layout helps in easy receipt locating, packing, issuing and inspection of goods, dispatching the goods, effects proper storage and preservation and also simplifies stock taking. The efficiency of the storage system may be compared and assessed in terms of unit cost (per volume or weight) of moving goods through storage sites or storage area over a given period. It usually takes into account the elements of labour, space and equipment needs and costs. In any specific storage system design, these may be some advantages in sacrificing the accessibility to stocks in favour of getting more stores in less space, or vice versa. Thus, while it is not possible to arrive at any absolute criterion for the efficiency of one storage system over another, the selection of the right system will depend upon assessing and evaluating the requirements in terms of the manufacturing strategy or the distribution strategy.

The size, design and layout of a warehouse must, therefore be an integral part of a wider systems design and management strategy. It must also be realized, that what happens in a warehouse affects the whole range of other activities. The objectives of a good warehouse layout are to achieve the following:

- Maximum ease of operation with ready accessibility of major materials.
- Straight line or semi-circular flow of materials from receipt to dispatch with minimum back tracking.
- Maximum use of space for storage.
- Minimum handling of materials.
- Minimum traverse distances while materials get transported into and transported out.
- Lowest possible need and use of material handling devices.
- Preservation and protection of materials by ensuring adequate environmental conditions internally and externally.
- Elimination of pilferage and thefts.
- Easy, prompt and speedy physical verification and stock taking.
- Flexibility of operations with a futuristic outlook.

The information needs while planning the layout are as follows:

- Classification of store items by size, number, weight, frequency of handling, handling arrangements required and perishability.

Check Your Progress

1. What do you know about a private warehouse?
2. What are the key financial factors affecting the warehouse decision?
3. What are the co-operative warehouses?.

- Floor space and height required to store the items.
- Deciding in advance whether to go for fixed location, random location or zoned location of stocks or a combination of these.
    - Fixed location: Stock can be found immediately without a complex system of recording but there can be a considerable waste of space.
    - Random location: Space is better utilized, but good and elaborate records have to be kept where the materials are.
    - Zonal location: Goods of a particular product group are stored in a given area.
- Units withdrawn/ issued at a time.
- Maximum number of units to be stored at one time.
- Storage facility required that best suits the items.
- List of available storage space for different kinds of storage facilities.
- Determining the sequence of laying out storage space for locating the materials.
- Size and shape of the space available for laying out the stores.
- Preparation of flow diagram of the flow of materials through the stores.

The features of a good layout are as follows:

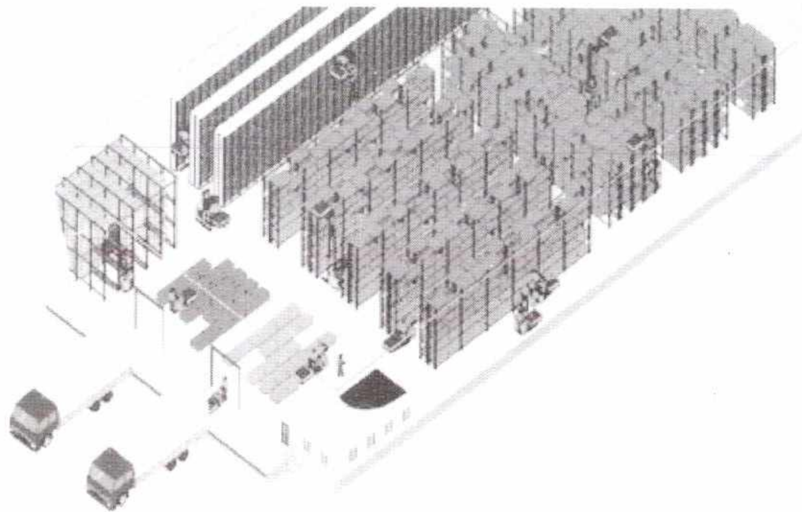
1. Provision of sufficient number of passages (aisles) besides sufficient number of cross aisles. The area earmarked for aisles should not exceed 30% of the total area.
2. Provision of multi-dimensional shelves or sections for storing different items.
3. Receiving-end and dispatch-end are at opposite points.
4. Provision of emergency exit.
5. Provision for fire-fighting facilities advantage points and free of encumbrances.
6. Provision of lighting, ventilation, heating and refrigeration system installed wherever required.
7. Offices, cloak rooms and toilets provided close to the receiving yard and dispatch yard.
8. The space for receipt and inspection provided adjacent to the main stores.
9. Effective utilization of the third dimension.
10. Proper markings made at various storage spaces to facilitate location and identification.
11. The layout should permit the use of modern material handling equipments.
12. Provision for future expansion.

13. A pleasing and hygienic environment through proper selection of the colour of walls, provision for exhaust and cleaning.

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2.5 PRINCIPLES AND FACILITIES

The goal of warehouse layout design is to optimize your warehousing functions and achieve maximum efficiency and space utilization. A warehouse is typically divided into areas to support your everyday processes. These areas include: reserve storage, forward pick, cross docking, shipping, receiving, assembly/special handling lines, and quality/inspection area.



Designing a new facility starts with analyzing your current and projected data on the activities in each of these areas, including the receiving, shipping and inventory levels. This data should be supported by other considerations such as process flows, material handling equipment, type and styles of racking equipment, special handling requirements, and personnel.

When considering the layout and operation of any warehouse system, there are fundamental principles that embody a general philisophy of good practice. The principles are:

1. Using the most suitable unit load
2. Making the best use of space
3. Minimizing movement
4. Controlling movement and location
5. Providing safe, secure and environmentally sound conditions
6. Maintaining a minimum overall operating cost

Successful warehouse layouts must adhere to the principles, regardless of material being stored to:

(i) Maximize the use of space

(ii) Maximize the use of equipment

(iii) Maximize the use of labour

(iv) Maximize accessibility to all items, and

(v) Maximize protection of all items

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Although the objectives of warehouse layout and operation are easily recognized, warehouse layout problems are often complicated by large varieties of products needing storage, varying areas of required storage space and drastic fluctuations in product demand.

Therefore, an effective layout design of the warehouse is required to address these problems and accomplish the objectives.

2.5.1 Space Requirements Planning

The first step in laying out a warehouse is to determine the overall space requirements for all warehouse processes. The space requirements for each process should be computed and summarized to estimate the overall building requirements. Effective space utilization makes good use of total building volume and not merely the floor area.



For example, when calculating the space required for the receiving and shipping staging area, the number of receiving and shipping dock doors and the turnaround time for each dock would be considered. A common practice is to allocate enough staging space behind each dock door to accommodate a truckload's worth of material.

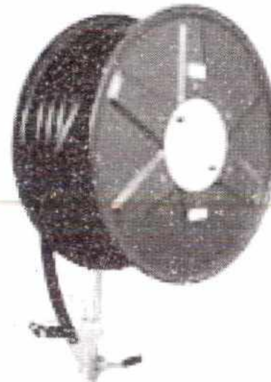
Some other processes that would be considered in the space requirement planning include case picking, pallet storage, broken case picking, packing and unitizing, customizing, cross docking and more.

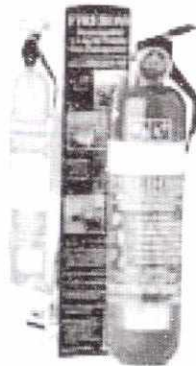
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Warehouses should also be designed based on current and future needs to:

- Facilitate changes in business/agency growth, and size/population of office and warehouse spaces within the building. Warehouse space should be easily adapted to new functions such as office (on ground or upper levels), computer centers, or light industrial/fabrication.
- Accommodate need for future loading docks, truck space, and car parking spaces if space configuration changes through effective site design.
- Address material handling technologies and business practice, such as "just-in-time" storage, which have fundamentally changed operation of warehouses and distribution centers, and will continue to do so.
- Include roof design with built-in extra structural capacity to handle addition of future rooftop equipment.
- Be designed with fire protection capacity to accommodate storage of materials with a greater fire hazard, especially needed with high plastic product content or packaging, and plastic shrink-wrapped pallets.









It should also be able to maximize utilization of space while providing adequate circulation paths for personnel and material handling equipment such as forklift

trucks. We should also use higher bays to take advantage of height allowances in the space.

Alternative material handling methods will determine other building aspects, such as aisle widths, lighting design, need for mezzanine space, fire protection, and egress design. Businesses will often use different methods of storage handling simultaneously for different products.

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2.5.2 Factors Affecting Warehouse Layout and Planning

The following are the key factors affecting warehouse layout and planning:

Outside Factors

Various external factors influence the design and layout of a warehouse operation. These factors have to be taken into consideration to achieve an optimum overall system.

- Size & configuration of site must be adequate to accommodate the required equipments
- Site access must be adequate for the types of vehicle and volume of traffic using that particular site
- Local authority plans The proposed warehouse can be greatly affected by the government development plan
- Site details: Characteristics of the facilities found in the site such as drainage and ground.
- Financial considerations: Consider the rents, costs of ownership, investments grants.
- Building factors: Existing building to be used as a warehouse.



Inside Factors

These factors have a dominant influence on how effectively a warehouse can be operated.

- Flow of goods in the warehouse: 'U' flow or through flow

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- Movement of people and equipments
- Access to stock and minimize congestion
- Identification of stock and codes
- Stock location, rotation (FIFO)
- Stock checking requirements
- Stock replenishment
- Handling of goods in and out of the warehouse
- Supervision, safety, stock security

Warehouse aisles and gangways need to be properly designed in order to achieve one of the warehouse objectives, which is maximizing effective use of space. The widths in between should be adequate enough for movement of people and equipment. It is ideal to have separate doors for people on foot and for forklift trucks.

Some areas should also be set aside for other warehouse activities. These include:

- Areas for loading and unloading vehicle
- Staging or temporary storage areas
- Office space, washroom and lunch rooms
- Area for repacking, labelling, marking
- Area for equipment storage and maintenance
- Hazardous or high-value items

2.5.3 Usefulness and Constraints of Layout Design

Usefulness of layout design:

1. An effective warehouse layout design can help to optimize the efficiency and space utilization. With the five main areas of operations, goods can move in swiftly from the unloading area, into the main storage; a picker can also pick goods from the picking area. Congestions are minimized and these help to increase the efficiency of the different tasks in the warehouse. By storing goods with a plan to locate them neatly; more space can be utilized; either horizontally or vertically.
2. There would also be higher labour efficiency and lesser errors. A layout plan would minimize the movement of the employees and the time used for moving can be used to do other operations or work; thus increasing labour efficiency. A neatly planned warehouse would have lesser errors such as picking the wrong item or storing the wrong goods in the wrong place.
3. Safety and security of a warehouse would most likely be enhanced through an effective layout because employees would know where the walking spaces are and no goods would be left lying around.

Constraints of layout design

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Space Constraint: It is very important that when you plan the design layout of the warehouse, you need to think how to make it that the use of space is at the optimum level. By making the best use of space, you will be able to have a higher amount of inventory storage. Making the best use of space does not only mean the floor areas which are horizontal but also vertical. Maximising the use of space can also help to reduce the total cost of the warehouse. Therefore, it important to take note of the usage of space when designing the warehouse layout.

Constraint of the five main areas: Beside making best use of the space, when we design the layout, we should also consider where are we going to locate the different areas of the warehouse (goods in, main storage, order picking, marshalling, goods out). It is because by considering this factors, you will be able to minimize the movement and congestion in the warehouse and therefore, the rate of accident in the warehouse would also decrease. One example is the separation of the main storage and the order picking area.

Space layout

Large-scale drug warehouses with very narrow aisle pallet storage and vertical carousels for small items are designed to hold as much product as possible in an area where space is very expensive.

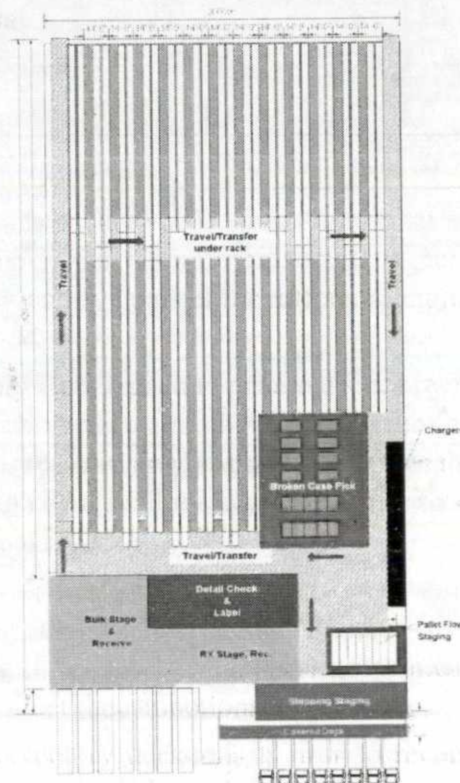


Fig. 2.1: Aisle pallet storage

Dock

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Cross dock layout where pre-picked and stretch wrapped pallets from a local supplier of bulky seasonal items came in the night before, and were then shipped to the chains stores in their own trucks the next day. Picked pallets of product and cartons received and sorted directly to outgoing store lanes (another form of cross docking) were all accumulated in dedicated store lanes for cross dock shipping with little handling or order picking being required.

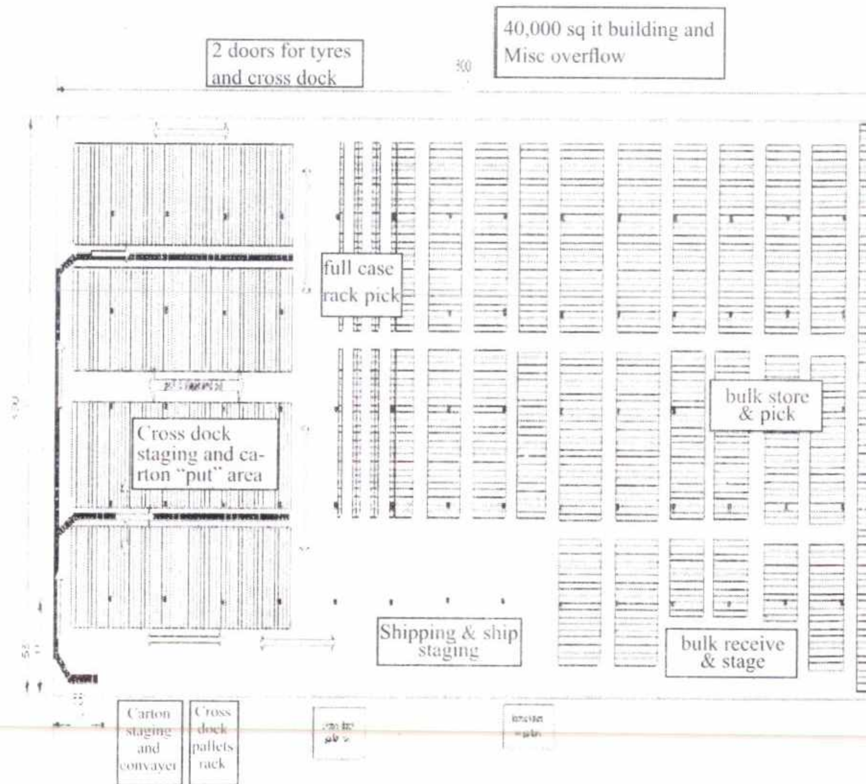


Fig. 2.2: Cross dock layout

2.6 TYPES OF WAREHOUSE OPERATION

There are five main areas of warehouse operation. They consist of the following:

1. Goods in – incoming of goods
2. Main store – reserve stock
3. Order picking – forward stock
4. Marshalling
5. Goods out – outgoing goods

Each area is briefly categorized as below:

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Goods In (Incoming of goods)

- Receipt – unload, temporary hold
- Check – correct goods received, grade, package, quantity, damage or shortages
- Record receipts & discrepancies
- Unpack, repack if necessary
- Decide goods location

Main Store – reserve store

- Locate goods in reserve storage area
- Confirm goods location to control function
- Issue goods to replenish order picking stock

Order Picking – forward store

- Select goods for customer orders
- Pack & check
- Packaging material store

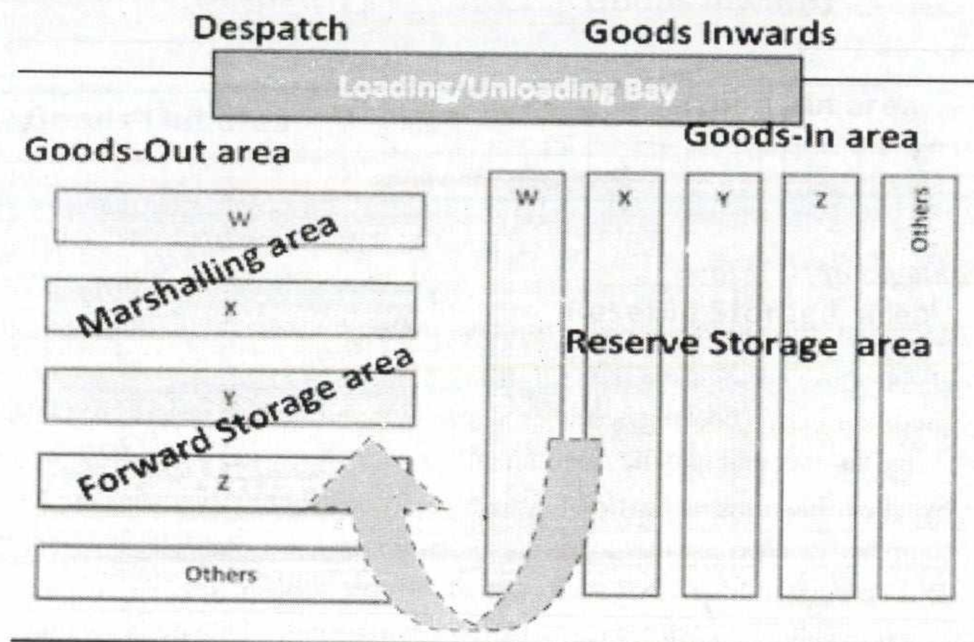
Marshalling

- Assemble goods by customer, or by vehicle load

Goods Out – outgoing goods

- Loading facilities for vehicles
- Vehicle despatch schedules

These areas can be illustrated in the image below:



Throughflow and U flow

Material Flow Planning

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Planning the flow of materials is important in a warehouse. This is because with a plan, we would most likely be aware of the location of items in the warehouse and also the status and location of the handling equipments. With this information, better control of the warehouse can be achieved.

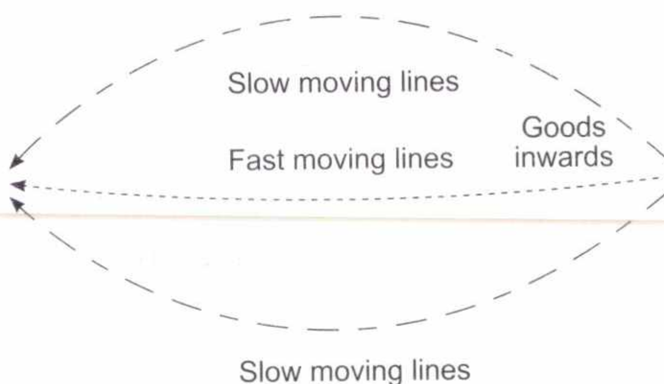
There are two main approaches of the plan of material flows. They are the 'U' flow and 'Through' flow.

'U' flow

A 'U' flow occurs when the goods receipt and dispatch functions are located at the same end of a warehouse building.

Products flow in at receiving, move into storage in the back of the warehouse, and then to shipping, which is located adjacent to receiving on the same side of the building.

Items with higher throughput level are located closer to the loading bays. An example of a 'U' flow design can be seen in the diagram below.



Advantages of 'U' Flow

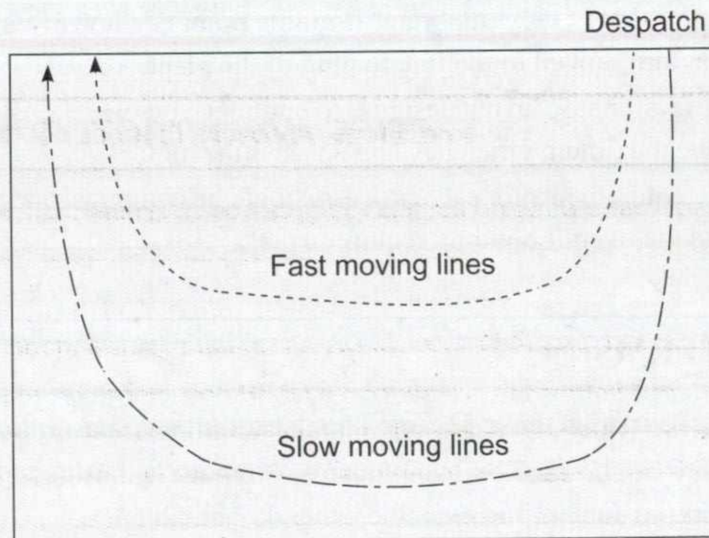
- Excellent utilization of dock resources because the receiving and shipping processes can share dock doors
- Facilitating cross docking because the receiving and shipping docks are adjacent to one another and may be co-mingled
- Excellent lift truck utilization because put away and retrieval trips are easily combined and because the storage locations closest to the receiving and shipping docks are natural locations to house fast moving items
- Yields excellent security because there is a single side of the building used for entry and exit

'Through' flow

'Through' flow happens when separate loading bay facilities for outbound and shipping are provided, often at the opposite end of warehouse.

Products flow in at receiving, move into storage, picking area and then the marshalling and depatch area in a straight line.

Items with a higher throughput level are located at the center of the warehouse because the total distance travelled would be shorter. An example of a 'Through' flow layout design is shown in the diagram below.



The major disadvantage of a 'Through' flow layout is goods need to travel the full length of the warehouse, even for goods that have a higher throughput level. It is also harder to control and less flexible.

When is it better to adopt a 'Through' flow?

- When there is a risk of interference or confusion between goods in and goods out
- When goods inwards vehicles and dispatch vehicles are very different; for example differences in platform height or nature of unit load
- When a warehouse is connected to a production plan

2.7 SUMMARY

- Warehouses are commercial buildings that are used to store goods. They can be used by manufacturers, importers, businesses, exporters, wholesalers, customers and even the general public.
- Before making a strategic planning to lower the storage cost, an interlining supplier is necessary to understand the basic concept of warehouse ownership classification.

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Check Your Progress

Fill in the blanks

4. Warehouse .... is the internal design or the functional design.
5. Designing a new facility starts with analyzing your current and projected data on the activities in each of these areas, including the receiving, shipping and .... levels.
6. An effective warehouse layout design can help to optimize the efficiency and ....

NOTES

- A private warehouse is operated by the firm owning the product. The facility (land and building) could be either owned or leased.
- A public warehouse is also known as 'duty paid warehouse'. Public warehouses are very useful to the business community as they can meet their storage needs easily and economically by making use of the public warehouse, without heavy investment.
- By storing his goods in a bonded warehouse the importer gains some control without paying the duty.
- Warehouse layout is the internal design or the functional design. An efficient layout and design is very important from the point of view of its functioning which is in turn, linked to the functioning of the plant.
- The goal of warehouse layout design is to optimize your warehousing functions and achieve maximum efficiency and space utilization.
- The space requirements for each process should be computed and summarized to estimate the overall building requirements.

2.8 KEY TERMS

- **Warehouses:** Warehouses are commercial buildings that are used to store goods. They can be used by manufacturers, importers, businesses, exporters, wholesalers, customers and even the general public.
- **Warehouse layout:** Warehouse layout is the internal design or the functional design. An efficient layout and design is very important from the point of view of its functioning which is in turn, linked to the functioning of the plant.
- **Handling charges:** Handling charges often involve a table of decreasing charges based on volume.

2.9 ANSWERS TO 'CHECK YOUR PROGRESS'

1. A private warehouse is operated by the firm owning the product. The facility (land and building) could be either owned or leased. These warehouses are owned and operated by the big manufacturers and merchants to fulfil their own storage needs.
2. Financial factors include operational cost (cost of running the warehouse) and capital cost (cost of setting up the warehouse).
3. These warehouses are owned, managed and controlled by co-operative societies. They provide warehousing facilities at the most economical rates to the members of their society.
4. Layout

5. Inventory
6. Space utilization

2.10 QUESTIONS AND EXERCISES

NOTES

Short Answer Questions

1. Briefly explain the need for warehousing.
2. Define break-bulk warehouses and refrigerated warehouses.
3. What are the characteristics of an ideal warehouse?
4. Define warehouse layout and cross docking.

Long Answer Questions

1. Write a detailed discussion on different types of warehouse and their utility.
2. How you will design an efficient warehouse layout?
3. What are the principles and facilities of warehouse layout?
4. What are the different types of warehouse layout?

UNIT 3 INTERNAL OPERATIONS

NOTES

Structure

3.0 INTRODUCTION

Logistics Management

An important feature of Walmart's logistics infrastructure was its fast and responsive transportation system. The distribution centers were serviced by more than 3,500 company owned trucks. These dedicated truck fleets allowed the company to ship goods from the distribution centers to the stores within two days and replenish the store shelves twice a week. The truck fleet was the visible link between the stores and distribution centers. Walmart believed that it needed drivers who were committed and dedicated to customer service. The company hired only experienced drivers who had driven more than 300,000 accident-free miles, with no major traffic violation.

Walmart truck drivers generally moved the merchandise-loaded trailers from Walmart distribution centers to the retail stores serviced by each distribution center. These retail stores were considered as customers by the distribution centers. The drivers had to report their hours of service to a coordinator daily. The coordinator scheduled all dispatches depending on the available driving time and the estimated time for travel between the distribution centers and the retail stores. The coordinator informed the driver of his dispatches, either on the driver's

arrival at the distribution center or on his return to the distribution center from the retail store. The driver was usually expected to take a loaded truck trailer from the distribution center to the retail store and return back with an empty trailer. He had to dispatch a loaded truck trailer at the retail store and spend the night there. A driver had to bring the trailer at the dock of a store only at its scheduled unloading time, no matter when he arrived at the store. The drivers delivered the trailers in the afternoon and evening hours and they would be unloaded at the store at nights. There was a gap of two hours between unloading of each trailer. For instance, if a store received three trailers, the first one would be unloaded at midnight (12 a.m.), the second one would be unloaded at 2 a.m. and the third one at 4 a.m. Although, the trailers were left unattended, they were secured by the drivers, until the store personnel took charge of them at night. Walmart received more trailers than they had docks, due to their large volume of business.

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Walmart maintained a strict vigil over its drivers by keeping a record of their activities through the "Private Fleet Driver Handbook". The purpose of the book was to educate the drivers with regard to the code of conduct. It also included the terms and conditions regarding the safe exchange of trailers with the store personnel and the safety of Walmart's property. This book also contained a list of other activities, the non-compliance of which would result in the termination of the driver. To make its distribution process more efficient, Walmart also made use of a logistics technique known as 'cross docking.' In this system, the finished goods were directly picked up from the manufacturing plant of a supplier, sorted out and then directly supplied to the customers. The system reduced the handling and storage of finished goods, virtually eliminating the role of the distribution centers and stores. There were five types of cross docking.

In cross docking, requisitions received for different goods from a store were converted into purchase or procurement orders. These purchase orders were then forwarded to the manufacturers who conveyed their ability or inability to supply the goods within a particular period of time. In cases where the manufacturer agreed to supply the required goods within the specified time, the goods were directly forwarded to a place called the staging area. The goods were packed here according to the orders received from different stores and then directly sent to the respective customers. To gain maximum out of cross docking, Walmart had to make fundamental changes in its approach to managerial control. Traditionally, decisions about merchandising, pricing and promotions had been highly centralized and were generally taken at the corporate level. The cross docking system, however, changed this practice. The system shifted the focus from "supply chain" to the "demand chain," which meant that instead of the retailer 'pushing' products into the system; customers could 'pull' products, when and where they were needed. This approach placed a premium on frequent, informal cooperation among stores, distribution centers and suppliers with far less centralized control than earlier.

NOTES

About Walmart

Walmart Stores, Inc. is the largest retailer in the world, the world's second-largest company and the nation's largest non-governmental employer. Walmart stores, Inc. operates retail stores in various retailing formats in all 50 states in the United States. The Company's mass merchandising operations serve its customers primarily through the operation of three segments. The Walmart stores segment includes its discount stores, super centers, and neighbourhood Markets in the United States. The Sam's club segment includes the warehouse membership clubs in the United States. The Company's subsidiary, McLane Company, Inc. provides products and distribution services to the retail industry and institutional foodservice customers. Walmart serves customers and members more than 200 million times per week at more than 8,416 retail units under 53 different banners in 15 countries. With fiscal year 2010 sales of $405 billion, Walmart employs more than 2.1 million associates worldwide. Nearly 75% of its stores are in the United States ("Walmart International Operations", 2004), but Walmart is expanding internationally. The Group is engaged in the operations of retail stores located in all 50 states of the United States, Argentina, Brazil, Canada, Japan, Puerto Rico and the United Kingdom, Central America, Chile, Mexico, India and China.

Source: *Docstoc.com*

The building blocks or operational criteria of an ideal Warehouse Management System includes location, structure, roof height and flooring, design and external layout, utilities and facilities in the premise, internal layout design, storage infrastructure, material handling equipments, lighting and safety equipments and mechanisms, office infrastructure, IT and communications infrastructure, power and backup services and finally accessibility of the location and availability of labour. The list can be exhaustive and depends upon specific needs of each buyer's business.

The efficiency of warehousing operations is highly dependent not only upon the physical infrastructure but the system and intelligence that controls, directs and manages the physical transactions. A robust WMS capable of managing inventory and locations which is RF driven or enabled, would be the backbone of a good efficient warehouse.

The Warehouse Management System controls two sets of operations:

- On the inventory front, the system maintains inventory in the warehouse at zone and individual location level, SKU level, pallet-wise, carton-wise and unit-level inventories for multiple customers and allows specific inventory attributes and parameters to be built in to manage, allocate or block the inventory. The system also provides options to adapt FIFO, LIFO or other methods of inventory flow.
- On the operations front the system manages, controls and directs all operations including receiving processes, put away processes, order processing, inventory

allocation, picking process, packing process and finally shipment along with inventory updating. The intelligent system guides and helps the operations manager to schedule and manage all operations for various groups and teams simultaneously depending upon the work load and pattern and thereby manage resource allocation too.

3.1 UNIT OBJECTIVES

After going through this unit, you will be able to:

- Know the measures and metrics of a warehouse operation
- Discuss the role of logistics in a warehouse
- Explain the meaning of localization of materials in a warehouse
- Identify and classify material in a warehouse
- Discuss the material management and problems related to the shipment process.

3.2 MEASURES AND METRICS OF WAREHOUSE OPERATION

Warehouses are one of the most labour-intensive nodes in a supply chain. While there have been major innovations towards increasing warehouse productivity through process and mechanical automation, they still constitute a substantial part of the supply chain costs.

Warehouses generally measure their effectiveness through various metrics that can be grouped in one of the following categories:

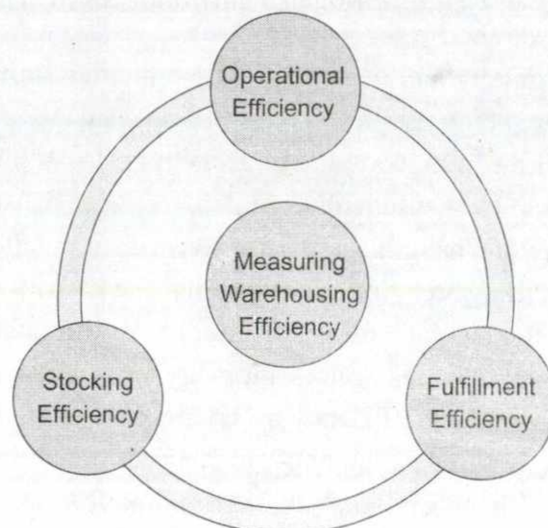


Fig. 3.1: Measuring warehousing metrics

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1. **Operations:** The operational metrics measures the efficiency of warehouse operations. This is primarily focused on the number of activities performed. The examples of the metrics in this category would be number of cases received and shipped, number of picks and put-away tasks completed, units handled, dollar value of the handled merchandise, and so on. The main focus of the operational metrics is to measure the efficiency of the material handling operations within the warehouse, whether they are handled through labour, automation or a combination of the two. Equipment like the conveyors, forklifts, automated carousel systems, diverters, bar code scanners, sorters, label applicators, dimensioning systems, automated guided vehicles, and so on can help enhance operational efficiency in a warehouse.
2. **Fulfillment:** The second set of metrics at the warehouses measures their ability to fulfill orders on time and in full. Response time and perfect order metrics fall in this category and consist of measuring fill-rates, on-time fulfillment, and pick and ship accuracy (right product in right quantity for right customer) at the warehouse. Other metrics contributing towards perfect orders, like correct invoicing and order entry is generally outside the scope of warehouse functions. Fulfillment metrics measure the efficacy of the inventory planning and replenishment systems for the warehouse. While these functions are generally centralized, they directly affect the warehouse's ability to fulfill demand. More and more companies are realizing this and providing inventory planning visibility to the warehouse managers. Since the inventory and replenishment planning systems can project future build-up of inventories, such data can be used directly by the warehouses to enhance their labour and stocking efficiencies as well.
3. **Stocking Efficiency (Slotting):** This set of metrics primarily measures the efficacy of the warehouse space usage. How does the warehouse make use of its space, horizontally and vertically? These metrics show how racking and slotting needs are being fulfilled and how these decisions affect the operations by affecting picking, put-away, and replenishment task efficiencies, active and reserve locations. How efficiently are item volume, density and orientation, demand patterns, and handling patterns used in deciding the stocking locations of the items in the warehouse? Incidentally, the metrics that measure these (stocking) efficiencies are reflected directly in the operational metrics: a well slotted warehouse maximizes the warehouse cube and simultaneously enhances the operational efficiency by saving the overall distance travelled in the warehouse, work balancing to avoid congestion, enhanced ergonomics by making it easier to handle products through optimally stocking them by location, height, and handling characteristics, and finally the order fulfillment accuracy by considering demand patterns.

There could be a fourth category of warehouse metrics as the financial metrics that measure the costs of labour, operations, utilities, depreciation of capitalized assets, and fixed costs. I have skipped these metrics; however, since they directly depend on one of the others mentioned above and will improve directly in response to the improvements in the other metrics.

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3.3 LOGISTICS IN WAREHOUSE

Warehousing activities whether in finished goods logistics or plant logistics, are very critical to the entire supply chain. Take the example of an automobile manufacturer who depends upon a 3PL to manage complete inbound activities including vehicle unloading, inventory management and JIT supplies to the plant. The manufacturing facility completely is dependent upon the 3PL service provider. Both the buyer and 3PL co-exist together at the same location, over a period of time the systems and operations get enmeshed and integrated in the process of localization and finding practical solutions. Logistics is an important part of every organisation. It is easiest to imagine a manufacturer, with forklift trucks unloading pallets from lorries and moving them around warehouses – but the same principles apply in any other organisation. When a rock band goes on tour they carry huge amounts of equipment.

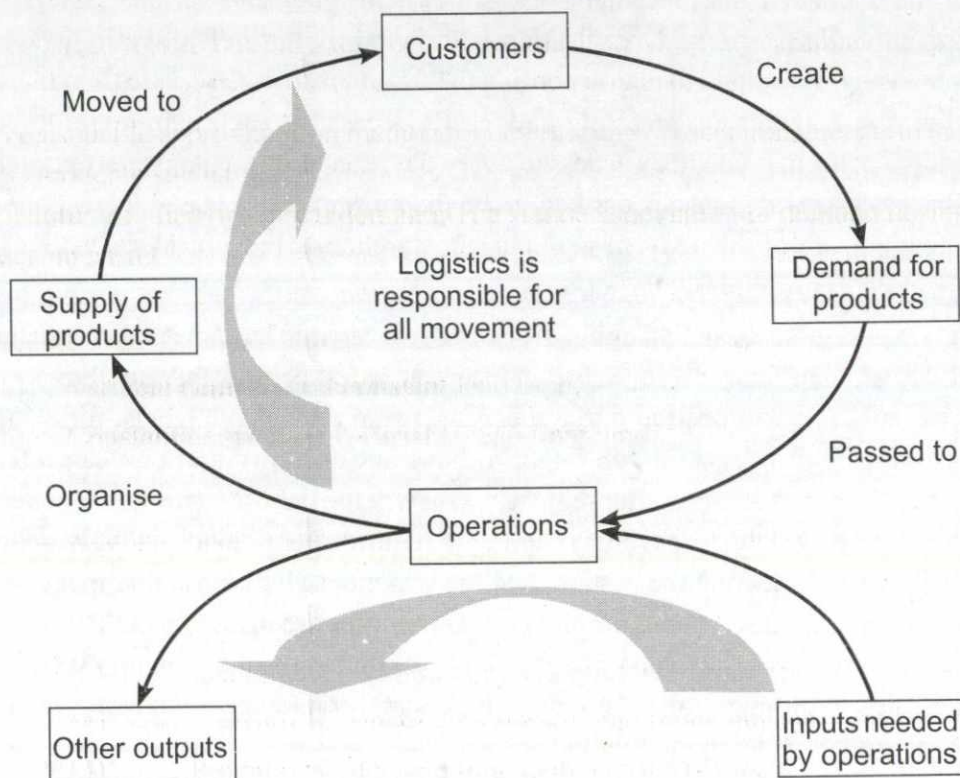


Fig. 3.2: Role of logistics in meeting demand

Check Your Progress

1. What is the significance of an effective WMS?
2. Define operational matrics.
3. What is the role of slotting matrics?

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Procurement buys everything that is needed on the tour, transport packs it and moves it to the next destination, receiving ensures that everything arrives safely, warehousing keeps things safe until they are needed, materials handling moves things between trucks and the stage, location decides where to perform.

Figure 3.2 suggests the role of logistics is an essential part of every trade. Customers generate demand for products, which operations create using necessary resources – and logistics move everything around this loop. Not only is logistics essential, but it is also expensive. Unfortunately, it is difficult to say exactly how expensive, because normal accounting conventions do not separate logistics costs from other operating expenditure, and there is always disagreement about which activities to include. As a result, very few organizations can put precise figures on their logistics costs, and many have almost no idea of the amounts involved. One obvious point, though, is that expenditure on logistics varies widely between different industries. Building materials, such as sand and gravel, have very high logistics costs compared with, say, jewellery, pharmaceuticals and cosmetics.

An effective warehouse logistics plan ensures that every item is kept efficiently and in the right place. This means that it will be simple to find when required, can be kept in the most appropriate conditions, understanding that you can always have the stuff you need on hand, when you need them. An efficient warehouse logistics plan may consider the placement of distinct item types and various factors such as health and also safety. Organisation is the vital thing to effective logistics and warehousing. You ought to plan according to how often anyone accesses certain types of things and, therefore, precisely how easily accessible each item ought to be. If you have items that you need access to every day, then putting them appropriately at the back of the warehouse is unlikely to be the most efficient use of the warehouse. Contemplate all of the items in your current warehouse and consider whether your stock alterations regularly or not.

On a regular basis changing stock doesn't always have to make warehouse logistics any harder once you have an effective safe-keeping and labelling system carried out. You will need to find a means of using updateable labels, for example C-profile label holders and you ought to have an inventory that you can refer to. While your own stock may alter regularly, you will have those items that you need to shift regularly and those that are not going to require attention normally. Warehouse logistics means meeting the demands of the warehouse and those that make use of it. While this typically means employees, some stores are open to people too, and in these kinds of cases, the quality of the signposts and signs that you apply will help make sales, minimizing the amount of time staff should spend showing men and women around and helping them choose.

Warehouse logistics can take care of the arrival and delivery of items but the importance of inventory placement and storage area inside the warehouse shouldn't be neglected.

3.4 LOCALIZATION OF MATERIALS IN A WAREHOUSE

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Inventory localization is a process by which existing inventory information can be augmented or localized and, by so doing, improves the accuracy of the inventory. To "localize" is to improve the precision of the inventory for a specific geographic area, which may be contiguous (e.g., watershed), or non-contiguous (e.g., individual polygons with a target leading species).

The inventory localization process includes those techniques for filling in missing data or changing information in the official inventory database based on:

- ad hoc field observations by district staff
- re-photo interpretation
- sub-unit inventories for special purposes

The need for inventory localization arises when users of the inventory information at the district level become aware of a consistent and persistent lack of accuracy in portions of the inventory. In most cases, the issue is brought to the attention of the Forest District Staff (FDS). The FDS then makes the decision on what course of action should be taken.

The FDS should document and catalog all reports of inventory inaccuracy. Proper documentation of inventory information complaints is essential to the success of any remedial measures that may be developed. Without a concise definition of the issues, the localization objectives cannot be met.

The objectives of the inventory localization process can be stated in general terms as:

1. To provide more accurate polygon information for strata or watersheds where problems have been identified.
2. To provide operational level information when such information is required.
3. To improve species composition, height and age attributes for target polygons.
4. To provide the FDSs with opportunities to improve their knowledge of the composition and complexity of the vegetation cover in their area of jurisdiction.

These objectives, which were based on identified needs of inventory information users, give the inventory localization programme better focus, but also expand its role to include providing data for planning purposes at the watershed and landscape levels. Funding for the programme should depend on business needs.

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"Localization" of product assortments raises inventory and margins

Retailers that offer local and regional product assortments, promotions, and pricing appear to have found a winning strategy. Although their inventory levels have grown marginally, primarily due to an increase in the number of stock-keeping units (SKUs), retailers engaged in this practice of "localization" have been able to sell more merchandise than their competitors—and at higher profit margins. That was one of the findings in the report Precision Inventory Management in the Age of Localization, which presented the results of research conducted by Retail Systems Research (RSR) in partnership with the Retail Industry Leaders Association (RILA.) The groups surveyed some 80 U S, Canadian, and European retailers from May to July 2009.

Twenty-nine percent of the survey respondent companies that were designated as "winners" (as opposed to companies classified as "laggards") have seen increased inventory levels. Meanwhile, 64 percent have achieved higher gross margins, and 55 percent experienced higher inventory turnover rates. "Winners associate better inventory management with the ability to localize the value offering to consumers," said Brian Kilcourse, a managing partner at RSR.

The study found that food, drug, and convenience stores are under more pressure to meet local consumer demands than other types of retailers. Fifty percent of the food, drug, and convenience store respondents said they face strong consumer demand for a localized product assortment, compared to only 37 percent of department and specialty stores, 33 percent of discount stores, and 25 percent of mass retailers. Yet food, drug, and convenience stores may have the hardest time meeting that demand: 58 percent said their trading partners don't have the flexibility the retailers need in their supply chains.

To manage the complexities that come with localization, leading retailers are starting to place a high value on a single demand forecast and store-level inventory management system. They place less value on such applications as logistics dashboards and transportation management as tools for managing inventory while providing a mix of localized goods, products, and pricing.

Source: *Precision Inventory Management In The Age of Localization, RSR Research and RILA, August 2009*

3.5 IDENTIFICATION AND CLASSIFICATION OF MATERIALS AND PRODUCTS IN WAREHOUSE

In a warehouse setting, materials examiners and identifiers receive, check, and visually and physically examine a variety of incoming material, equipment, parts, machinery, and commodities utilized, produced, or processed at the facility prior

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to acceptance into or removal from the system. They compare data relating to item characteristics, descriptions, conditions, and quantities against accompanying documents or computerized readouts and note discrepancies. They make initial classification determinations as to acceptance, rejection, and repair requirements by comparison with specific detailed criteria of acceptability such as go-on-go gauges, amount of surface corrosion, as well as determining overages or shortages.

The normal way of identifying an article is by simple description, but this by itself is not satisfactory for the stock purpose. Several different names may be used for the same thing, for example a dust bin, refuse container or rubbish receptacle. Again in order to identify some article accurately a very long complicated description is required. Take for example paper used as stationery; there are many kinds of papers, to identify only one of them properly, it is necessary to say that it is typing paper with specific size and colour. Therefore, it is necessary to have some logical basis of identification which is more precise and less cumbersome. This can be done first by classifying the stock and assigning a code for each specific stock item.

Classification means systematic arrangement in groups or categories of stocks according to end use. The important principles of stock classification are the similar items should be associated with the similar ones; simplicity and ease of understanding of the stocks should be given paramount consideration. A code is a system of symbols or numbers or a combination of symbols and numbers used for representing data for purposes of communication or for storage or for processing information.

Each type of stock should be given a number or letter or a combination of numbers and letters, which prevent it from being mixed with other types of stocks. Some of the requirements for stocks coding are the following:

- One stock type should not be mistaken for another
- The coding should preferably tell the type of stock
- The coding system should be simple and easy to understand
- The coding system should be flexible and able to take any reasonable increase in the number of stocks

3.6 MANAGING THE MATERIAL/PRODUCTS TURN IN WAREHOUSE (FIFO/LIFO)

Logistics is the management and control of the efficient and effective flow of storage of goods and services between an origin point and a point of consumption. Organizations use different methods to achieve the efficient flow and control of inventory. Through logistics, organizations try to ensure that items process and ship before they expire or perish. First in first out (FIFO) is one of the methods used by many logistics companies to control inventory.

FIFO

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Organizations use FIFO to organize warehouses and inventory. Organizations that use FIFO organize inventory so that the merchandise stored first is the merchandise that is retrieved first. This method of warehouse organization is particularly effective for inventory that has perishable or date-specific qualities. Logistics companies can also use the FIFO system throughout the supply chain, including the inventory, warehousing and transportation of all material handled by the company.

LIFO

Last in first out is another method used by logistics companies to handle inventory. LIFO restocks merchandise by moving older items to the back and making room for any new items that are the same. In the LIFO system, the last items stocked are the first items sold. This method is useful for merchandise that has no sell-by or expiration date. Since the company will sell the older products in the future, an organization that uses the LIFO system should control the distribution of the merchandise at timely intervals to ensure that products do not remain warehoused for excessive periods of time.

Both FIFO and LIFO are generally recognized inventory control systems used by logistics companies. Logistics companies implement specific inventory management systems to control the entire inventory in a warehouse. A logistics organization tries to implement the right systems to ensure the effective movement of merchandise. Logistics companies can use both FIFO and LIFO to protect the inventory cycles of warehoused products and to provide replenishment methods that report projected inventory status and handle the management of inventory.

Case Study of Walmart: Inventory Management

Walmart had developed an ability to cater to the individual needs of its stores. Stores could choose from a number of delivery plans. For instance, there was an accelerated delivery system by which stores located within a certain distance of a geographical center could receive replenishment within a day. Walmart invested heavily in IT and communications systems to effectively track sales and merchandise inventories in stores across the country. With the rapid expansion of Walmart stores in the US, it was essential to have a good communication system. Hence, Walmart set up its own satellite communication system in 1983. Explaining the benefits of the system Walton said, "I can walk in the satellite room, where our technicians sit in front of the computer screens talking on the phone to any stores that might be having a problem with the system, and just looking over their shoulders for a minute or two will tell me a lot about how a particular day is going. On the screen, I can see the total of the day's bank credit sales adding up as they occur. If we have something really important or urgent to communicate to the stores and distribution centers, I, or any other Walmart

executive can walk back to our TV studio and get on that satellite transmission and get it right out there. I can also go every Saturday morning around three, look over these printouts and know precisely what kind of work we have had."

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Walmart was able to reduce unproductive inventory by allowing stores to manage their own stocks, reducing pack sizes across many product categories, and timely price markdowns. Instead of cutting inventory across the board, Walmart made full use of its IT capabilities to make more inventories available in the case of items that customers wanted most, while reducing the overall inventory levels. Walmart also networked its suppliers through computers. The company entered into collaboration with P&G for maintaining the inventory in its stores and built an automated reordering system, which linked all computers between P&G and its stores and other distribution centers. The computer system at Walmart stores identified an item which was low in stock and sent a signal to P&G. The system then sent a re-supply order to the nearest P&G factory through a satellite communication system. P&G then delivered the item either to the Walmart distribution center or directly to the concerned stores. This collaboration between Walmart and P&G was a win-win proposition for both because Walmart could monitor its stock levels in the stores constantly and also identify the items that were moving fast. P&G could also lower its costs and pass on some of the savings to Walmart due to better coordination.

Employees at the stores had the 'Magic Wand,' a hand-held computer which was linked to in-store terminals through a radio frequency network. These helped them to keep track of the inventory in stores, deliveries and backup merchandise in stock at the distribution centers. The order management and store replenishment of goods were entirely executed with the help of computers through the Point-of-Sales (POS) system. Through this system, it was possible to monitor and track the sales and merchandise stock levels on the store shelves. Walmart also made use of the sophisticated algorithm system which enabled it to forecast the exact quantities of each item to be delivered, based on the inventories in each store. Since the data was accurate, even bulk items could be broken and supplied to the stores. Walmart also used a centralized inventory data system using which the personnel at the stores could find out the level of inventories and the location of each product at any given time. It also showed whether a product was being loaded in the distribution center or was in transit on a truck. Once the goods were unloaded at the store, the store was furnished with full stocks of inventories of a particular item and the inventory data system was immediately updated.

Walmart also made use of bar coding and radio frequency technology to manage its inventories. Using bar codes and fixed optical readers, the goods could be directed to the appropriate dock, from where they were loaded on to the trucks for shipment. Bar coding devices enabled efficient picking, receiving and proper inventory control of the appropriate goods. It also enabled easy

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order packing and physical counting of the inventories. In 1991, Walmart had invested approximately $4 billion to build a retail link system. More than 10,000 Walmart retail suppliers used the retail link system to monitor the sales of their goods at stores and replenish inventories. The details of daily transactions, which approximately amounted to more than 10 million per day, were processed through this integrated system and were furnished to every Walmart store by 4 a.m., the next day. In October 2001, Walmart tied-up with Atlas Commerce for upgrading the system through the Internet-enabled technologies. Walmart owned the largest and most sophisticated computer system in the private sector. The company used Massively Parallel Processor (MPP) computer system to track the movement of goods and stock levels. All information related to sales and inventories was passed on through an advanced satellite communication system. To provide back-up in case of a major breakdown or service interruption, the company had an extensive contingency plan. By making effective use of computers in all its company's operations, Walmart was successful in providing uninterrupted service to its customers, suppliers, stockholders and trading partners.

About Walmart

Walmart Stores, Inc. is the largest retailer in the world, the world's second-largest company and the nation's largest non-governmental employer. Walmart Stores, Inc. operates retail stores in various retailing formats in all 50 states in the United States. The company's mass merchandising operations serve its customers primarily through the operation of three segments. The Walmart Stores segment includes its discount stores, supercenters, and neighborhood markets in the United States. The Sam's club segment includes the warehouse membership clubs in the United States. The company's subsidiary, McLane Company, Inc. provides products and distribution services to retail industry and institutional foodservice customers. Walmart serves customers and members more than 200 million times per week at more than 8,416 retail units under 53 different banners in 15 countries. With fiscal year 2010 sales of $405 billion, Walmart employs more than 2.1 million associates worldwide. Nearly 75% of its stores are in the United States ("Walmart International Operations", 2004), but Walmart is expanding internationally. The group is engaged in the operations of retail stores located in all 50 states of the United States, Argentina, Brazil, Canada, Japan, Puerto Rico and the United Kingdom, Central America, Chile, Mexico, India and China.

Source: *Docstoc.com*

3.7 PROBLEMS AND ISSUES IN SHIPMENT PROCESS

A warehouse goes through a standard receiving process when shipments arrive to replenish stocked inventory. The warehouse coordinator or inventory clerk has a set

procedure to check all received shipments and that paperwork is handled efficiently. If the warehouse personnel encounter any receiving problems, the issues can be addressed quickly so that the correct shipment is available for customers.

The following are the key issues linked with the shipment process:

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Shipment Identification

When a delivery truck arrives at the unloading dock, the inventory clerk speaks with the driver concerning the shipment. The inventory checks records to validate that the particular item was ordered and set for delivery. The inventory clerk signs her name on the delivery shipping notice as she accepts the shipment from the driver.

Product Count

After the shipping notice is signed, the warehouse personnel unload the crates from the truck. She counts the number of crates or boxes so the quantity matches the delivery driver's shipping notice. Each crate is opened and an exact count of the received product is taken. Any discrepancies in the count from the invoice slip are noted so that the purchasing department can rectify the situation with the product manufacturer.

Product Inspection

The inventory clerk checks all of the products for any damage caused during shipping. Damaged products are set aside so the manufacturer can retrieve the items and offer replacements. The delivery driver must review that there are damaged products in the shipment and initial the documentation regarding the damaged products before leaving the warehouse. Depending on the manufacturer's policy, the driver may take the products at that time to bring back replacements.

Receiving Documentation

Warehouse personnel assign inventory numbers to products before stocking the items on shelves. The inventory clerk inputs all product information into the warehouse data system. She syncs the data with all other departments requiring the information, including customer service, the sales department and accounts payable department. The inventory clerk files all written documentation such as the invoices and packing slips for auditing purposes.

3.8 SUMMARY

- The efficiency of warehousing operations is highly dependent not only upon the physical infrastructure but the system and intelligence that controls, directs and manages the physical transactions.

- The operational metrics measures the efficiency of warehouse operations.
- Fulfillment metrics measure the efficacy of the inventory planning and replenishment systems for the warehouse.
- Warehousing activities whether in Finished Goods logistics or Plant logistics, are very critical to the entire supply chain.
- Inventory localization is a process by which existing inventory information can be augmented or localized and, by so doing, improves the accuracy of the inventory.
- In a warehouse setting, materials examiners and identifiers receive, check, and visually and physically examine a variety of incoming material, equipment, parts, machinery, and commodities utilized, produced, or processed at the facility prior to acceptance into or removal from the system.
- Organizations that use FIFO organize inventory so that the merchandise stored first is the merchandise that is retrieved first.
- LIFO restocks merchandise by moving older items to the back and making room for any new items that are the same.

3.9 KEY TERMS

- **Operational Metrics:** The operational metrics measures the efficiency of warehouse operations.
- **Fulfillment Metrics:** Fulfillment metrics measure the efficacy of the inventory planning and replenishment systems for the warehouse.
- **Inventory Localization:** Inventory localization is a process by which existing inventory information can be augmented or localized and, by so doing, improves the accuracy of the inventory.
- **FIFO:** First in first out
- **LIFO:** Last in first out

3.10 ANSWERS TO 'CHECK YOUR PROGRESS'

1. A robust wms capable of managing inventory and locations which is rf driven or enabled, would be the backbone of a good efficient warehouse.
2. The operational metrics measures the efficiency of warehouse operations. This is primarily focused on the number of activities performed.
3. This set of metrics primarily measures the efficacy of the warehouse space usage.
4. Inventory localization
5. Code

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Check Your Progress

Fill in the Blanks

4. .... is a process by which existing inventory information can be augmented or localized and, by so doing, improves the accuracy of the inventory.
5. A .... is a system of symbols or numbers or a combination of symbols and numbers used for representing data for purposes of communication or for storage or for processing information.
6. .... is the management and control of the efficient and effective flow of storage of goods and services between an origin point and a point of consumption.
7. Organizations that use ....organize inventory so that the merchandise stored first is the merchandise that is retrieved first.
8. ....restocks merchandise by moving older items to the back and making room for any new items that are the same.

6. Logistics
7. FIFO
8. LIFO

3.11 QUESTIONS AND EXERCISES

Short Answer Questions

1. Discuss the significance of operational metrics.
2. Explain the role of logistics in warehouse.
3. State the difference between the LIFO and FIFO method of material management.
4. Explain localization of materials in the warehouse.

Long Answer Questions

1. Analyze the different types of metrics to measure the warehouse efficiency.
2. Write a note on logistics in the warehouse.
3. Discuss the key problems and issues in shipment process.
4. Discuss the management of material turn in a warehouse.
5. How will you identify and classify materials and products in the warehouse?

UNIT 4 WAREHOUSING EQUIPMENT

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Structure

4.0 INTRODUCTION

Various types of equipment are required to ensure the smooth execution of work in a warehouse. All equipment should be properly stored when not in use and a regular maintenance schedule posted. Warehouse staff should be trained in standard daily maintenance practices and the correct use of equipment. Where necessary, they should be equipped with personal safety equipment such as work gloves, work boots, goggles, etc.

The following are the basic warehouse equipments:

- Sufficient quantities of standard forms, calculators and stationery to keep proper storage records

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- Small tools for opening cases, such as hammers, pliers, crowbars, steel cutters
- Tools and materials for store repair and simple maintenance
- Supplies for reconditioning damaged packaging, such as bags, needles, twine, oil containers, stitching machine, strapping machine, adhesive tape and small containers or cartons
- A sampling spear for inspecting foodstuffs
- Scales for weighing goods
- Standard wooden pallets in sufficient numbers - ideally international
- Standardization organization's "Euro" type (120 × 80cm)
- Two-wheel hand trolleys for moving supplies within the warehouse
- A pallet-jack to move pallets
- A forklift where pallets are to be loaded and offloaded from trucks
- Brooms, dust pans, brushes, shovels, sieves, refuse bins for cleaning and disposing of collected waste
- First aid kits, flashlights, fire extinguishers and other fire-fighting equipment both inside and outside the warehouse
- Weighing scales
- Ladders

Warehouse equipment is maintained to prevent accidents and breakdowns from occurring. Maintenance activities consist of inspections, regular servicing and monitoring performance for failure trends, as this will enable symptoms to be recognised before failure occurs.

Equipment maintenance has a strong health and safety bias. Often health and safety legislation will impose on management an obligation for safe systems of work. Ensuring safe policies and procedures of work will require an examination of men, machinery, methods, materials and environmental aspects.

Some areas to pay attention to:

- Planned maintenance
- Maintain equipment
- Maintain building
- Completion of maintenance records

4.1 UNIT OBJECTIVES

After going through this unit, you will be able to:

- Identify the material handling equipment and system
- Know the role of material handling in logistics
- State the different types of material handling equipments

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- Describe the storage types and storage unit management
- Discuss the key concepts like industrial shelving, industrial storage bins, and industrial storage cabinets
- Define spill containment and industrial waste disposal.

4.2 MATERIAL HANDLING EQUIPMENT AND SYSTEM

"*Every time you pick up an article without changing its form, you add to its cost but not to its value*" - Mr. Henry Ford.

Materials Handling Systems (MHS) can be defined as "the set of all pieces of equipment that make possible the physical movement within the distribution chain -including the production chain and the warehouse - of raw material, work-in-progress and finished goods". Therefore, materials handling systems perform a wide range of activities. In general, materials handling refers to the necessary tasks to be performed in order to move a load around the factory floor as well as to store and freight it. Materials handling takes place one way or another along all the links of the supply chain including production, distribution, and storage and retail functions. Handling in a warehouse or distribution center will have a major impact on how effectively materials flow through the system, and on the cost, resource and time taken to get orders out to the customer. In addition, handling equipment can be capital-intensive, and the act of movement can be labour-intensive. Material handling equipment eases manual handling chores and enhances operational efficiency.

Various methods of handling goods are used in warehousing, from manual through to automated or robotic systems, and a broad categorization could be:

- Manual handling
- Manually operated trucks and trolleys
- Powered trucks and tractors, operator controlled and driven
- Powered trucks and trolleys, driverless, computer-controlled
- Crane systems
- Conveyors
- Robotics

4.3 ROLE OF MATERIAL HANDLING IN LOGISTICS

Material handling in the logistics system is concentrated in and around the warehouse facility. A basic difference exists in the handling of bulk materials and master cartons. Bulk handling is a situation where protective packaging at the master carton level is unnecessary. Specialized handling equipment is required for bulk loading, such as for solids, fluids, or gaseous materials.

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Over the years a variety of guidelines have been suggested to assist management in the design of material handling systems. The following are the major ones:

1. Equipment for handling and storage should be as standardized as possible.
2. When in motion, the system should be designed to provide maximum continuous product flow.
3. Investment should be in handling rather than stationary equipment.
4. Handling equipment should be utilized to the maximum extent possible.
5. In handling equipment selection, the ratio of deadweight to payload should be minimized.
6. Wherever practical, gravity flow should be incorporated in system design.

The factors to be considered when deciding on the appropriate type of handling system for a particular application include:

- Types of load being handled including the unit load characteristics
- Quantity of material being handled
- Frequency of movement
- Distances to be travelled, horizontal and vertical
- Numbers and locations of pick-up and drop points
- Adjacent activities
- Nature of terrain
- Flexibility required

The principles governing the design and use of handling systems include:

1. Control of position and movement
2. Elimination of unnecessary movement and minimization of the necessary movement
3. Selection of the most appropriate handling method to meet the system requirements
4. Provision of adequate handling capacity
5. Integration of handling with the storage and other adjacent operations
6. Thorough and effective operator training
7. Effective equipment maintenance for operational availability and safety
8. Safe methods of handling and working practices

Handling systems are classified as:

- Mechanized
- Semi automated
- Automated
- Information-driven

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A combination of labour and handling equipment is utilized in mechanized systems to facilitate receiving, processing, and/or shipping. Generally, labour constitutes a high percentage of overall cost in mechanized handling. Automated systems, in contrast, attempt to minimize labour as much as possible by substituting capital investment in equipment. An automated handling system may be applied to any of the basic handling requirements depending on the situation. When selected handling requirements are performed using automated equipment and the remainder of the handling is completed on a mechanized basis, the system is referred to as semi automated. An information-directed system uses computers to maximize control over mechanized handling equipment. Mechanized handling systems are the most common. However, the use of semi-automated and automated systems are rapidly increasing. As noted earlier, one factor contributing to low logistical productivity is that information-directed handling has yet to achieve its full potential.

4.4 UNLOADING AND LOADING EQUIPMENT

The following are the major loading and unloading equipments:

Conveyor

Conveyor systems are used for moving material between fixed points, for holding material as short-term buffer, for sortation and for process industry applications such as separation, grading and cooling.

The general characteristics of the conveyor systems are:

- High through-put with few operators and low power requirement;
- Suitable for fixed routes, and floor surfaces are not critical as they are for fork trucks;
- Fast response and suitable for continuous or intermittent movements;
- Can utilize very sophisticated movement control.

Common types include the following:

1. **Belt conveyor:** This is an endless belt, which is held under tension between two rollers, one of which is driven. The belts may be stainless steel mesh or wire, synthetic rubber, or a composite of canvass, steel and polyurethane or polyester. Flat belts are used to carry packed foods, and trough-shaped belts are used for bulk materials. Belts may be inclined up to 45°, if they are fitted with cross slates to prevent the product from slipping.

   Metal or wooden slatted conveyors are used instead of belts for greater load bearing and a reduced risk of damage to the conveyor.

2. **Roller conveyor and skate wheel conveyor:** Free-running (unpowered) rollers or wheels are either horizontal, to allow packed foods to be pushed along, or

slightly inclined for transport under gravity. Rollers are heavier and stronger than wheels and therefore, able to carry heavier loads.

3. **Chain conveyor:** This is used to move churns, barrels, crates and similar bulk containers by placing them directly over a driven chain, with protruding lugs, located at floor level. A similar monorail conveyor is used for moving meat carcasses on an overhead track.
4. **Screw conveyor:** This consists of a rotating helical screw inside a metal trough. It is used to move bulk foods (for example flour and sugar) and small-particulate foods (for example peas or grains). The main advantages are the uniform, easily controlled discharge, the compact cross-section (without a return conveyor) and total enclosure to protect the product and to prevent contamination. They may be horizontal or vertically inclined but are generally limited to a maximum length of 6 m as, above this, high friction forces result in excessive power consumption.
5. **Vibratory conveyors:** These impart a vertical movement to food, to raise it a few millimetres off the conveyor, and a forward movement, to move the food along the conveyor. The amplitude of vibration is adjusted to control the speed and direction of movement. This precise control makes vibratory conveyors useful as feed mechanisms for processing equipment. They are also useful, for moving sticky or fried foods (snack foods).
6. **Flight conveyors:** Here, bulk material (for example grain or flour) is dragged through an enclosed channel by an endless chain fitted with hooks or flights. Chain speeds are low (6-10m min^{-1}) and the inclination is limited to 30°, above which the material slips back.

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Rolling Ladders/Elevators

Four common types of elevators are as follows:

1. **Bucket elevators:** These consist of metal or plastic buckets fixed between two endless chains. They have a high capacity for free-flowing powders and particulate foods. The shape and spacing of the buckets, the method of discharge and the speed of the conveyor (15-100 m min^{-1}) control the flow rate of materials.
2. **Magnetic elevators:** These are used for conveying cans within canneries. They have a positive action in being able to hold the cans in place and are thus able to invert empty cans for cleaning and operate at high speeds with minimal noise.
3. **Flight elevators:** These are essentially inclined flight conveyors. They have flexibility in use for a wide range of free-flowing bulk foods, high capacity and good space utilization.

4. **Pneumatic elevators:** Powders or small-particulate foods are suspended in air, which is re-circulated at 1000-1700 m min^{-1} inside a system of pipes.

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The air velocity is critical; if it is too low, the solids settle out whereas, if it is too high, there is abrasion damage to the pipe surfaces. Similar equipment is used to classify foods and to dry foods. A build-up of static electricity is prevented by control over the moisture content of the food and earthing the equipment. This is necessary when conveying powders are used to minimize the risk of dust explosions. This type of equipment has a smooth operation and cannot be overloaded. It has few moving parts; low maintenance costs and only requires a supply of compressed air at 700 kPa

Lifting equipment

The following are the key equipments used in lifting the material:

- *Cranes:* Cranes are the key equipment used in lifting the heavy material. The different types of cranes are single girder bridge cranes, double girder bridge cranes, single girder gantry cranes, jib cranes, and overhead stacker cranes.
- *Electric Hoists:* Industrial hoists are widely used for lifting. They are generally inexpensive and reliable. They increase the safety associated with lifting and enable the movement of much larger unit loads than would be possible with many other economical lifting options. An electric hoist can be defined as a suspended machinery unit using wire rope or chain for vertical lifting or lowering of freely suspended unguided loads. Because the primary reason cited for hoist failure is the failure to consider the duty environment of the hoist, it is useful to consider duty factors in the hoist selection process.

4.5 CARRYING EQUIPMENTS

There is a number of equipment that is used to carry material from one place to another. The following are some important ones:

Platform Trucks

Platform truck is premium equipment normally used for carrying goods in bulk quantity.

Industrial Carts and Industrial Scales

Industrial carts are used in many situations. They are inexpensively manufactured for diverse and specific applications. Common construction materials include aluminum/magnesium, steel, and wood. Because these trucks are so inexpensive, it makes sense to design them for specific material handling functions. In this way, it is possible to increase the cube utilization within the truck for material handling optimization.

Aluminum or magnesium carts generally carry 300-500 pounds of material, while steel or wooden carts can be used to carry approximately 1000 pounds to 2000 pounds, respectively. The trucks range in weight from as little as 20 pounds for aluminum trucks to as much as 125 pounds for wooden trucks.

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4.6 PALLET EQUIPMENTS

Pallets are probably the most common platform for moving unit loads. Perhaps the most obvious area of concern associated with the use of pallets today involves cost and quality trade-offs. Poor quality pallets annually cost industry billions of dollars in the form of product damage, lost productivity, and damaged handling. A key decision affecting the overall life cycle cost of pallets is the materials used in their manufacture which can include wood, pressed wood fiber, corrugated fiberboard, plastic or metal. More wooden pallets are sold each year than any other type due to the versatility, low cost, biodegradability and recyclability of this material. Pressed wood fiber is a combination of wood fibers and organic resins which eliminates the need for nails and enables the moulding of pallets into more space efficient designs. Disposable, corrugated fiberboard pallets can be made of recycled paper materials and provide a light weight, low cost alternative for one way shipping when loads do not need to be stored outdoors. Durable plastic and metal pallets may provide the low cost alternative over the full pallet life cycle despite their high initial cost. Both of these materials are recyclable, can be sanitized for clean applications, and can be used in the most demanding applications. The table in this section summarizes some of the trade-offs associated with different materials used for the manufacture of pallets and the typical applications associated with each.

The pallet equipment can be classified into the following categories:

4.6.1 Pallet Trucks

The full featured ergonomic pallet truck is an economical way for one person to move heavy pallet loads without the use of a fork truck. Proven ergonomic design has been tested for providing years of reliable usage. This pallet truck includes two articulating steering wheels and two front load rollers. Ergonomic design requires only 75 lbs. of pulling force when fully loaded. Steering wheels include bearing dust covers for added life. Nose wheels are located on the front edge of each fork to assist in clean pallet entrance and exit. Reinforced triple formed steel forks provide twice the strength of standard single-formed forks. It is equipped with internally mounted solid steel adjustable push rods. Spring loaded loop handle automatically returns to vertical position when not in use. Chrome-plated hydraulic pump piston is for long seal life.

1. Powered pallet trucks

Hand pallet trucks, with capacities up to a max of 2 tonnes, are probably the most commonly used trucks for the horizontal movement of pallets. It is not uncommon to see these trucks lifted on to the back of the vehicle for positioning pallets during

loading and unloading. However, for frequent movements, and where there are inclines to be negotiated, battery-powered trucks are preferable in terms of operator effort and safety, and these can be pedestrian-or rider-controlled.

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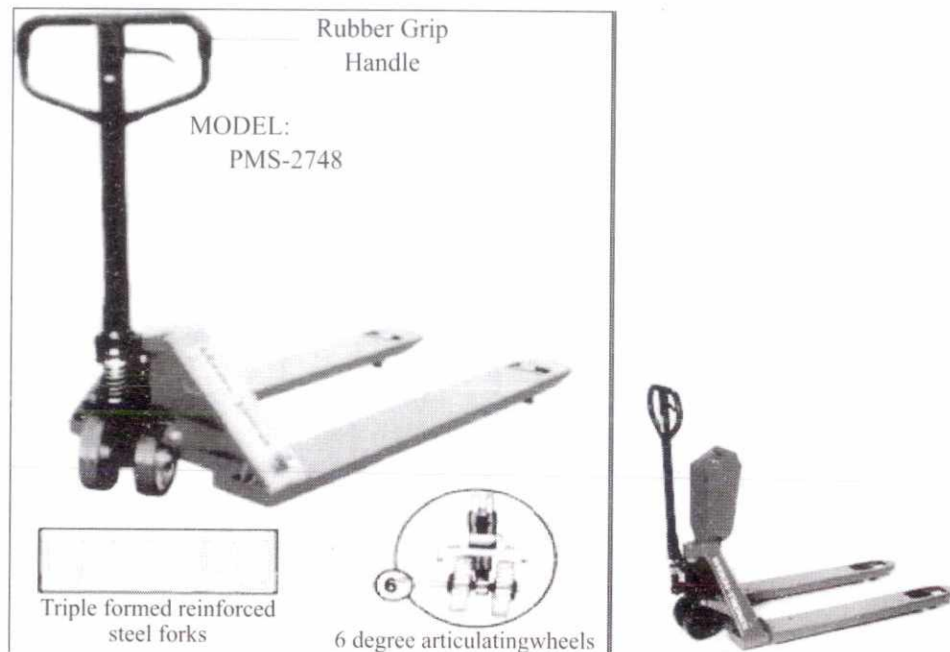


Fig. 4.1: Pallet truck and counter scale pallet truck

Source: *www.forklifttruck.com*

Counter balanced fork-lift trucks

Counterbalanced fork-lift trucks carry the payload forward of the front wheels, so there is always a turning moment lending to tip forward. To balance this, a counter balance weight is built into the rear of the machine, hence the name. These machines capacity varies from 1,000 kgs to 45,000 kgs with a lift height of up-to 6/7 metres.

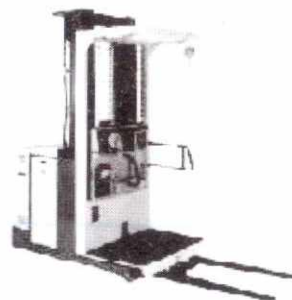


Fig. 4.2: Counter balanced truck

Source: *www.forklifttruck.com*

Reach trucks

Reach trucks are designed to be smaller and lighter than counter-balanced trucks and to operate in a smaller area. Its capacity varies from 1,000 kgs to 3,500 kgs with

a max fork-lift up to about 11 metres. This is achieved by having a mast that can move forward or back in channels in the outrigger truck legs. Then picking up or setting down a load, the truck is turned through 90 degrees to face the load location; the mast reaches forward, places or retrieves the load, and is retracted back into the area enclosed by the wheels.

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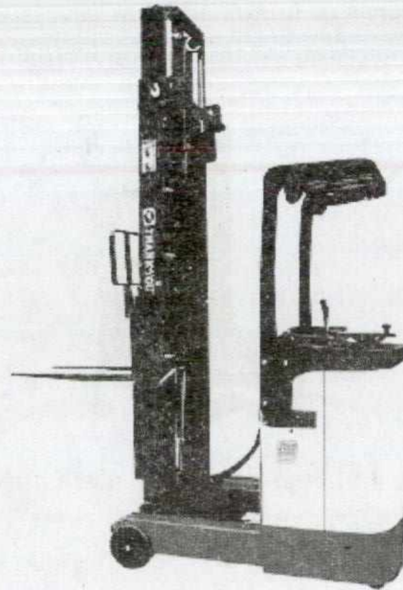


Fig. 4.3: Reach truck

Source: *www.forklifttruck.com*

Double reach trucks

A conventional reach truck can only reach one pallet deep into racking. For accessing double deep racking a double reach truck has to be used, which uses a pantograpgh mechanism to achieve the additional reach. Double reach can also be achieved on some lighter trucks by the use of telescopic forks. Double reach machines are also used for side-loading pallets on to road vehicles, working only from one side of the vehicle.

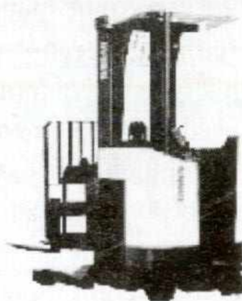


Fig. 4.4: Double reach truck

Source: *www.forklifttruck.com*

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Four-directional reach trucks

On a conventional reach truck, the front wheels always face forward, and steering is from the rear wheels. The 4D truck has an additional option of being able to turn the front wheels through 90 degrees and lock them in this mode. This effectively converts the truck into a side loader and is especially useful in stores and warehouses where the stock range consists of long loads. For access to say cantilever storage, very wide aisles would be necessary if this option were not available.

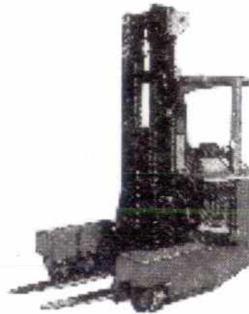


Fig. 4.5: Four-directional reach trucks

Source: *www.forklifttruck.com*

Stacker trucks

These are fairly light weighted trucks with max capacities up to 2000 kgs. There are pedestrian, stand-on and ride-on versions. Pallets are put into or taken out of storage racking by the truck legs being driven into the space either under the bottom pallet (beam supported). When picking up pallets at floor level, the forks have to be lowered right down on to the outrigger legs, so perimeter-based pallets cannot be used, since they would be sprung apart as soon as the forks were raised. This problem is overcome if the lowest pallets are located on low beams with sufficient space underneath to accommodate the outrigger. These trucks are usually limited to about a 6 metre lift, but they can operate in 90-degree turning aisles of only 2 metres or less.

2. **Non-powered hand pallet trucks**

These trucks are designed to carry unit loads on pallets from one location to another, generally in indoor settings. Because unit loads can be quite heavy, the distances transported using this type of equipment is generally short. In many settings, hand pallet trucks are used to supplement motorized truck fleets. They are extremely efficient for transporting unit loads short distances when high lifting is not required. They can be used to position materials very precisely. Generally speaking, non-powered hand trucks cannot be used to lift more than 8,000-10,000 pounds and cannot lift a unit load to a height more than 8 inches. For heavy duty applications, steel wheels are required while lighter duty applications require only nylon or polyurethane construction. These trucks can range in weight from 200 to 400 pounds.

4.6.2 Rack System

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There are numerous pallet rack configurations used in full pallet operations, from standard back-to-back single pallet depth configurations to double-deep rack, push-back rack, drive-in/drive-thru rack, and flow rack. The best racking configuration for your operation will be based on the total number of pallets per sku, pallets per pick, and the length of time the product is in the rack prior to shipment. There are a lot of tradeoffs in choosing a racking configuration including storage density, picking productivity, equipment costs, and the ability to maintain first-in first-out.

As the name implies, pallet racks are a structure or framework that are built to house pallets. Often, the pallet racks are made of steel piping, and may include cast iron netting on each level. Typically, the racks are open on all sides. This design makes it easy to store empty pallets as well as pallets that are loaded with supplies or finished goods. Pallets can be stacked on top of one another, and then inserted into each section of the racks for storage. Usually a pallet truck or forklift will be used to slide under the bottom pallet and transport the stack to its destination.

Along with basic forklifts, some pallet trucks are equipped with squeeze lift blades that have the ability to rotate. When goods are properly secured to the pallets, the squeeze lifts may be used to gently grip the pallet and materials and lift them into an open slot in the pallet racks framework.

Textile plants use pallet racks for a number of storage solutions. Raw materials may be housed in pallet racks as they await processing. Finished goods, such as yarn that is packed into shipping crates, may be stacked onto pallets and housed in pallet racks until the materials are purchased by customers. Pallet racks may also be used in the shops or supply areas for a textile plant. Many larger pieces of machinery used in the plants are delivered attached to pallets and may be stacked in a pallet rack until they are needed on the plant floor.

Pallet racks can also be of help in transporting goods from one location to another. Outfitting the interior of a trucking container with a pallet rack allows for the goods to be firmly secured into place. This will mean that the goods will not shift during transit, which will mean the goods have less of a chance of being damaged, or shifting to a point that they could tumble from the container when the rear doors are opened. As both a safety measure for people handling the goods and the protection of the products themselves, pallet racks are well worth the time and money they cost to install.

4.7 SAFETY MATTING AND INDUSTRIAL SAFETY EQUIPMENT

There are many varieties of industrial safety equipment available to protect the people who work in industrial settings. In the United States, many industries are subject to strict regulations that govern workplace safety and the industrial safety gear that

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must be available for use. This safety equipment is designed to protect the worker from hearing or vision loss, falls, burns, impact and other injuries.

The most common industrial safety equipment to be mandated by the U S Occupational Safety and Health Administration (OSHA) includes protection from vision and hearing loss. Vision can be protected in an industrial work environment by using safety glasses, facial shields or safety hoods. Safety glasses are designed to withstand direct impact from flying objects that could cause eye damage. Facial shields or hoods are designed to protect the whole face or head from chemical splashes or burns. Industrial hearing protection options include ear plugs and specially designed ear muffs that block out loud noises that could result in hearing loss.

Another type of industrial safety equipment protects the user from bumps or falling objects. Generally used in construction site and factory settings, safety helmets — commonly known as hard hats — protect the head from injury caused by bumps or falling objects. With the harness system that is designed into safety helmet construction, the wearer can bump his head on low objects or be hit by a falling object with relative safety.

Industrial workers who work on elevated surfaces require a special type of industrial safety gear that is designated for height safety. This type of industrial safety equipment includes harnesses and fall arrest systems. The purpose of this particular type of safety equipment is to protect the user from dangerous falls from heights.

Specialized industrial safety equipment may also include fire safety measures, such as extinguishing systems or specially designed suits to withstand high temperatures. This equipment is designed to protect the people working in the area and the equipment with which they are working. While most workplace settings are required to keep a fire extinguisher, specialized fire safety equipment is necessary in industrial settings where fire or extreme temperatures pose a serious threat to workers.

Even with a full outfit of industrial safety equipment available, accidents still happen, so it is important that workplaces provide emergency equipment for these situations. Commonly called a first aid kit, this emergency equipment is designed to render help to a person who has been the victim of an injury. While the most basic workplace safety and health action plans require a minimal amount of emergency equipment, such as bandages and eye wash, the requirements for emergency equipment of specific industries varies.

Check Your Progress

1. Why we need warehousing equipments?
2. Define material handling system.
3. What is the role of a conveyer system?

4.8 STORAGE TYPE AND STORAGE UNIT MANAGEMENT

The following are the different types of storage system:

1. Dynamic Storage Systems

High-Density Dynamic Storage Systems

These systems provide high-density storage for a variety of product types. They are often referred to as flow delivery systems or flow racks because of the way products are stored and retrieved from the systems. These systems can be broadly classified into three different types.

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(a) **High-rise, served by a guide truck:** Stacking heights to 40 feet. Narrow aisle, high-lift, or turret truck can be used under rail or wire guidance. Somewhat tighter tolerances than on conventional selective pallet racks.

(b) **Storage/retrieval (S/R) machine:** High degree of inventory control in large-volume, high-throughput applications. Operations frequently automated under computer control. Exacting tolerances on racks and floors. Storage heights can reach 75 feet or more.

(c) **High density:** Loads confined to specific lanes under automated control. Travelling carrier or retrieval mechanism removes loads on first-in, first-out basis. High-rise configurations can be used.

Horizontal and Vertical Carousels

Horizontal ıd vertical carousels are usually incorporated into automated material handling operations. These systems have movable racks or shelves that hold parts. The entire set of racks/shelves is rotated to bring the needed item to a pick position for retrieval (or a empty slot to the pick position for storage). Picking and placing is done manually or automatically. The manual weight limit is 35 to 40 lb. Typically, automatic extraction weight limit ranges from light loads to about 100 lb. The storage systems can be used for many applications, including maintenance parts, tooling, dyes, WIP, buffer storage, warehousing, and distribution.

The advantages associated in the use of carousels are:

(a) They are low cost, stand-alone, and modular storage systems.

(b) Both versions are available in a wide assortment of heights, lengths, and capacities.

(c) Automated or manual extraction methods are available for adding or removing stored products.

2. Automated Storage and Retrieval System (AS/RS)

AS/RS are commonly applied in two types of operations: warehousing or distribution and plant automation. These systems are typically high-rise systems capable of storing pallets, totes, drums, or other similar types of unit loads. The systems may be single aisle or large, multi-aisle systems. The storage/retrieval (S/R) machine is automated and capable of moving at high speeds within the captive aisle. Occasionally, multiple aisles will be equipped with a transfer mechanism so that one S/R machine can serve multiple aisles. These systems provide good inventory control

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as well as protection from damage and pilferage. These systems are typically used in conjunction with other automated material handling devices, such as automated guided vehicles. Some of the system advantages typically cited for AS/R systems are:

(a) The equipment enables reduced inventory levels through tightened control measures.

(b) Space requirements are reduced with high-rise, high-density storage techniques.

(c) Their ability to operate almost unattended. If the load or products can be identified automatically by their size or shape or by a code that can be read automatically, then the storage system can operate unattended.

(d) Capability to interface automatically with a number of different types of conveyors and other transportation equipment.

4.9 MATERIAL STORAGE SYSTEM

The type of materials passing through warehouses varies enormously, with different sizes, weights, shapes, levels of fragility and hazard characteristics. A major benefit of unit loads such as pallets is that they enable the use of standard storage systems and handling equipment, irrespective of what is handled. Nevertheless variations in throughput and order picking patterns make it appropriate to have different types of storage system, with different operational characteristics, so that systems can be selected that most closely match the needs of the wider system within which they are to operate.

The key factors influencing the choice of a storage system are:

- The nature and characteristics of the goods and unit loads held;
- The effective utilization of building volume—horizontal and vertical:
- Good access to stock;
- Compatibility with information system requirements;
- Maintenance of stock condition and integrity;
- Personal safety;
- Overall system cost;

When comparing the costs of different storage systems, it is not only the storage equipment cost that should be taken into account. Other cost elements that could be affected by the choice of system include:

- Space-land, building and building services;
- Fire protection;
- Handling equipment including maintenance;
- Staff;
- Information management systems.

One way of classifying storage systems could be:

- Bulk storage for solids, such as silos, bunkers and stockpiles;
- Loose item storage, ex-casting and fabrications held loose on the floor;
- Pallet storage systems;
- Small item storage for individual items or small unit loads;
- Non-standard unit loads such as long loads.

The location of stock within a store is an important aspect of stock management and can be considered at different levels of detail. For example, the overall positioning of stock within particular areas of the warehouse can influence the total amount of movement required to get material into and out of stock. It can also affect the efficiency with which order picking operations can be carried out by affecting the distance order pickers have to travel to get to the required stock.

4.9.1 Fixed and Random Stock Location

The effective storage capacity of a given installation is influenced by whether individual product lines are held in fixed and dedicated locations, or whether any product line can be located randomly in any available storage location. If a fixed location system is used, any specific location can be used for its designed product line, and never for any other product. Consequently the installation must be designed with enough capacity to hold the maximum stock of every product line. With random location, when any empty location can be utilized for any product line as required, the size of installation can be reduced, since the probability of every product being in stock at maximum stock level at the same time is virtually nil. In this case, the required storage capacity can be calculated from the sum of the average stock levels for all product lines, inflated by a factor, say 10%, to account for fluctuations about the average.

Random location is often used for reserve storage, which tends to take up the largest area in a warehouse, and fixed location for order picking stock, which enables the use of concepts such as popularity storage- fast-moving product lines located to minimize picker movement.

4.9.2 Palletized Storage Systems

Block Stacking

Block storage does not use any storage equipment. Loaded pallets are placed directly on the floor and built up in stacks, one pallet on top of another to a maximum stable height. The pallet loads must be capable of carrying the superimposed pallets, and the top of each load should be flat enough to provide a stable base for the next pallet. Block stacking is suitable for that part of the product range where there are few product lines, each with high stock level, and where very strict FIFO movement of stock is not required. The advantages are good use of area, flexibility to change the layout of the bocks and quick to stock for rapid throughput.

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Drive-in and Drive-through Racking

Although this is a racked storage system, it is operationally similar to block storage. There should only be one product line in each row, and the effective utilization of the pallet positions is about 70%. The racking structure supports the weight of the pallets so this system is suitable for high stock product lines, where strict FIFO movement is not required, but where the pallet loads are not strong enough or of regular enough shape to carry superimposed loads. This system consists of vertical support frames, tied at the top, with cantilever pallet support beams at different heights.

Push Back Racking

This type of racking is a comparatively recent development. Like drive-in racking it gives high-density storage and can be built to any height up to the maximum lift height of the lift trucks accessing it. Pallets can be stored up to about four deep in the racking, on either side of the access aisle. The basic operational difference between this system and block stacking or drive-in racking is the increased selectivity achieved. There should be no mix of product lines in any one lane, but there can be between the lanes in any row.

Adjustable Pallet Racking (APR)

Adjustable pallet racking is probably the most widely used type of pallet racking, and offers free access to every pallet held. It can be built to match the lift height of any forklift truck. Unit loads other than pallets can be stored using APR, and there is a range of accessories such as drum supports and channel supports for post pallets to facilitate this. The conventional way of laying out APR is to have one row single deep at each end of the installation, with back-to-back rows in between. This gives every truck aisle access to two rows of racking, and minimizes the number of aisles required.

APR is a flexible, versatile storage system, which gives excellent stock access. It is simple in concept, easily laid out, and damaged parts are easily replaced. It can be suitable for fast-moving and slow -moving stock, and for product lines with high or low levels of palletized stock-holding. However, APR does not make good use of volume of building volume.

Double Deep Racking

If some loss of totally free access to stock can be accepted, although not nearly as severe as in block, drive-in or push back storage, space utilization can be improved using double deep racking. This supports pallets on pairs of beams as in APR, but improves space utilization by eliminating alternate access aisles, and using a double reach fork-lift truck, which can access not just one but two pallets deep into the racking.

Powered Mobile Racking

Powered mobile racking is effectively single deep APR, with the racking, except the end or outer rows, mounted on electrically powered base frames. Operationally it has similar characteristics to APR, but it is slower in use, and the pallet position utilization is likely to be similar to APR at 90 to 95%. This type of storage is expensive in equipment and floor costs, and it tends to be slow in operation. However, it gives very dense storage, and is suitable for the typically large number of product lines forming the 'Pareto tail' of a product range, where individual product lines have low stock and low throughput. It also finds use in cold-storage applications where space costs are especially high, and however temperature variations are reduced by cutting the air space in the storage area.

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Pallet Live Storage

Live storage systems are made up of inclined gravity roll conveyors, laid out side by side and at a number of vertical levels. Pallets are fed in at the higher end and removed as required at the lower. Such a system imposes FIFO. The only accessible pallets are at the out feed end, so any one lane should only hold pallets of the same product line. Pallet live storage systems are suitable for very fast-moving product lines. They can provide effective order picking regimes, which automatically refill empty locations, and also provide physical separation between picking and replenishment operations.

Small Item Storage Systems

As with palletized storage systems, there is a range of different types of systems for holding small items. With small item storage it often happens that different systems are incorporated into one installation. For example, drawer units and cabinets may be built into a shelving installation. Consequently the concept of standard equipment sizes and modularity is important for small item storage systems.

The following lists are some of the storage systems used for small items:

- Shelving
- Tote bins
- Drawer units
- Dynamic systems—mobile and live storage
- Mechanized systems-carousels and mini loads

4.10 INDUSTRIAL SHELVING

Industrial shelving is also known as pallet racking and pallet shelving. It is a storage solution that makes it possible to store empty or loaded pallets vertically as well as horizontally. Composed of heavy metal components, the shelving is able to hold a

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number of heavy pallets without fear of collapse and damage to the goods stored in the pallets. In addition, the shelving is constructed to make it easy to use a forklift to store or retrieve the pallets from the device.

Pallet racking is commonly employed in many types of warehouses. The exact dimensions of the pallet racks will vary, depending on the sizes of the pallets used in the operation. It is possible to select from a range of standard size pallet shelving options, or have the shelving constructed to specifications if the business is using custom-made pallets as part of their storage solution.

Most designs for pallet shelving are open, meaning it is possible to view the pallets from any direction. One of the most common of all pallet shelving designs is known as the drive-in system. With this system, it is possible to use a forklift to store or extract a pallet by entering the frame of the shelving. Removing a pallet from the shelving involves sliding the lift blades into position between the top and bottom sections of the pallet, and backing out of the shelving with the extracted pallet.

A second pallet shelving system that is used in many cases is the drive-through design. This approach to pallet storage is very similar to the drive-in type, but has the advantage of being accessible from each end of the rack. Additional features available on these types of cantilever racks include the use of rollers to expedite the storage of pallets by allowing them to move easily to the rear of the shelf. Other designs are configured to allow the use of wheeled carts for the pallets to rest upon. The carts are mounted in the frame of the shelving and the wheels make it possible to move the pallet up and down the length of the shelf with ease.

Because pallet shelving is assembled using a series of supports and sections to create a sturdy frame of shelves, it is possible to tear down the frames and move them when necessary. However, when the pallet shelving is used in a warehouse, the frame is usually set in place, secured with bolts to prevent shifting and movement during loading and unloading, and will remain in the same location for a number of years.

4.11 INDUSTRIAL STORAGE BINS

Storage bins are containers designed specifically to fit on pallet jacks, hand-propelled, wheeled platforms used to lift and move palletized unit loads. Companies use storage bins to ship and store many types of cargo, from food to industrial materials. When the bins reach their destination, which is usually a warehouse, workers use pallet jacks to lift and stack them for transfer into storage areas or onto trucks. An assortment of standard-size bins is available for purchase, or they can be made to a customer's specifications.

Both standard and custom storage bins come in a choice of materials. They can be made of corrugated cardboard, fiberboard, plastic, metal or wood. Sides and floors may be solid, slatted, wire mesh, or a combination of solid bottoms and open sides.

Collapsible or rigid bins are available now or used from a number of manufacturers and retailers. They come in square or rectangular shapes that can be stacked for more efficient use of space in warehouses, shipping containers and trucks.

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Depending on their use, storage bins may be open or closed on top. Open bins are usually shrink-wrapped in heavy plastic prior to shipping. Binding stacks of boxes together with shrink wrap plastic increases stability when they are loaded on and off the pallet jack.

4.12 INDUSTRIAL STORAGE CABINETS

One of the leading causes of industrial fires is the improper storage and handling of flammable liquids. It is important to identify and inventory all chemicals in your workplace. Review the MSDS (Material Safety Data Sheet) for each chemical to determine characteristics and recommended storage practices. To avoid generating toxic gases and to prevent fires and explosions, it is important to segregate incompatible chemicals. Some local regulations require positive pressure ventilation. When regulation requires venting, Justrite cabinets include vents with flame arresters for ducting outdoors.

Safety storage cabinets serve several critical functions:

- Safely contain hazardous chemicals to reduce the risk of fire, protecting both personnel and facilities
- Identify, organize, and segregate dangerous liquids
- Improve efficiency by allowing solvents to be stored near the points of use
- Improve security with keyed locking mechanism

4.13 SPILL CONTAINMENT SYSTEM

Spill containment is where spills of chemicals, oils, sewage etc. are contained within a barrier or drainage system rather than being absorbed at the surface. Spill containment is a process that makes it possible to confine materials within a limited area when some sort of spill or overflow has taken place. This type of containment is relatively common when dealing with sewage, chemicals, or oils and is considered a safety measure that helps to minimize the impact of the spill on the environment. A variety of methods are used in the process of spill containment, depending on the nature of the material that must be contained and the potential of that material to negatively impact the environment if it were allowed to seep into ground water or nearby rivers.

In some cases, provisions for spill containment are part of the ongoing processing of different types of materials. For example, a containment system may be an essential component in the sewage system of a municipality. In this instance,

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containment areas are built into the system, making it possible to continue processing waste even in the event of excessive rain that threatens to block sewers and place additional stress on the water processing plants in operation throughout the system. Overflow channels make it possible to contain the sewage until it can be processed, rather than allowing the material to be introduced into local bodies of water or seep into the ground, events that would ultimately have a negative impact on the local ecological balance.

Emergency spill containment equipment is also common with the handling of many types of materials. For example, inflatable containment units may be quickly put into position in the event that a tank or other storage device containing oil products should rupture. The containment units provide a means of collecting the product as it escapes from the ruptured tank, effectively preventing the oil from coming into contact with the ground or local bodies of water. In this scenario, the use of the emergency spill containment units not only helps to protect the environment, but also makes the collection of the product easier to manage during the cleanup phase.

Over the years, the strategies used in spill containment have grown increasingly sophisticated. Many of the methods used today do not require human intervention in order to initiate a containment effort. For example, a number of sewage systems are constantly monitored by computer technology that is programmed to respond when levels in sewage ducts reach a certain level, allowing the process of containment to begin even as the system notifies humans charged with monitoring the overall operation. Thanks to these innovations, the ability to quickly and successfully contain railroad spills, oil spills, and spills involving hazardous chemicals is greater than at any time in the past.

4.14 INDUSTRIAL WASTE DISPOSAL

Industrial waste management generally refers to a set of strategies and approaches that aim to eliminate, reduce, reprocess or dispose of waste produced in an industrial setting. Industrial waste can be toxic, chemical, solid, liquid, or non hazardous. Typically, however, industrial waste management is concerned with the proper disposal of industrial byproducts that could be harmful to the environment. Some of the common approaches to industrial waste management include emphasis on recycling programs, incineration, and landfills.

In industrial production, many materials are employed to manufacture products and because of the scale of that production, a lot of waste is generally produced. As a result of the size of the problem, industrial companies employ waste managers to focus solely on the issue of proper and effective disposal of waste. Most of that focus is in complying with eco-friendly laws which are becoming more common by various governmental bodies. Some of these laws propose penalties in the forms of fines or increased taxes.

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There are many different approaches to industrial waste management. Waste may be collected and transported for disposal at another location, or it might be disposed of on site. Recycling or reusing are other solutions that industrial companies are implementing. All these solutions can help reduce the amount of industrial waste a company disposes of.

The type of industrial waste produced is an important factor in determining the most effective disposal method. Two of the most common methods of waste disposal are the use of landfills and incineration devices. Depending on the type of waste, it can be disposed of or buried underground at a landfill site. This approach, however, is limited, as certain materials are not dangerous to the environment. Chemical waste or other types of toxic waste are not dumped at landfills because it can seep into the groundwater and present a health concern to nearby populations. Incinerators are also used to burn waste materials in appropriate cases. Environmental groups, however, typically do not favour this approach because of the related emission of hazardous gases.

In general, recycling, when possible, is a favoured solution of industrial waste managers and environmentalists. Recycling has two general advantages: it is environmentally-friendly because it converts used products into usable materials, and it can be a source of revenue or reduce costs. A company can convert previously useless waste into a material that they may re-use in their own manufacturing process obviating the need to purchase that material anew, or the company can sell the material for a profit. Some of the most common recycling strategies employed in industrial waste management include biological and physical reprocessing, and energy recovery.

4.15 SUMMARY

- Warehouse equipment is maintained to prevent accidents and breakdowns from occurring.
- Materials Handling Systems (MHS) can be defined as "the set of all pieces of equipment that make possible the physical movement within the distribution chain—including the production chain and the warehouse—of raw material, work-in-progress and finished goods".
- Material handling in the logistics system is concentrated in and around the warehouse facility.
- Conveyor systems are used for moving material between fixed points, for holding material as short-term buffer, for sortation and for process industry applications such as separation, grading and cooling.
- Platform truck is premium equipment normally used for carrying goods in bulk quantity.

- Industrial carts are used in many situations. They are inexpensively manufactured for diverse and specific applications.
- Pallets are probably the most common platform for moving unit loads. Perhaps the most obvious area of concern associated with the use of pallets today involves cost and quality trade-offs.
- There are numerous pallet rack configurations used in full pallet operations, from standard back-to-back single pallet depth configurations to double-deep rack, push-back rack, drive-in/drive-thru rack, and flow rack.
- The type of materials passing through warehouses varies enormously, with different sizes, weights, shapes, levels of fragility and hazard characteristics.
- Industrial shelving is also known as pallet racking and pallet shelving. It is a storage solution that makes it possible to store empty or loaded pallets vertically as well as horizontally.
- Storage Bins are containers designed specifically to fit on pallet jacks, hand-propelled, wheeled platforms used to lift and move palletized unit loads.
- Spill containment is where spills of chemicals, oils, sewage etc. are contained within a barrier or drainage system rather than being absorbed at the surface.
- Industrial waste management generally refers to a set of strategies and approaches that aim to eliminate, reduce, reprocess or dispose of waste produced in an industrial setting.

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Check Your Progress

Fill in the Blanks

4. .... is suitable for that part of the product range where there are few product lines, each with high stock level, and where very strict FIFO movement of stock is not required.
5. .... is also known as pallet racking and pallet shelving.
6. .... are containers designed specifically to fit on pallet jacks, hand-propelled, wheeled platforms used to lift and move palletized unit loads.
7. .... is where spills of chemicals, oils, sewage etc. are contained within a barrier or drainage system rather than being absorbed at the surface.

4.16 KEY TERMS

- **Materials Handling Systems:** Materials Handling Systems (MHS) can be defined as "the set of all pieces of equipment that make possible the physical movement within the distribution chain — including the production chain and the warehouse — of raw material, work-in-progress and finished goods".
- **Industrial Shelving:** Industrial shelving is also known as pallet racking and pallet shelving. It is a storage solution that makes it possible to store empty or loaded pallets vertically as well as horizontally.
- **Storage Bins:** Storage bins are containers designed specifically to fit on pallet jacks, hand-propelled, wheeled platforms used to lift and move palletized unit loads.
- **Spill Containment:** Spill containment is where spills of chemicals, oils, sewage etc. are contained within a barrier or drainage system rather than being absorbed at the surface.
- **Industrial Waste Management:** Industrial waste management generally refers to a set of strategies and approaches that aim to eliminate, reduce, reprocess or dispose of waste produced in an industrial setting.

4.17 ANSWERS TO 'CHECK YOUR PROGRESS'

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1. Warehouse equipment is maintained to prevent accidents and breakdowns from occurring. Maintenance activities consist of inspections, regular servicing and monitoring performance for failure trends, as this will enable symptoms to be recognised before failure occurs.
2. Materials Handling Systems (MHS) can be defined as "the set of all pieces of equipment that make possible the physical movement within the distribution chain –including the production chain and the warehouse – of raw material, work in progress and finished goods".
3. Conveyor systems are used for moving material between fixed points, for holding material as short-term buffer, for sortation and for process industry applications such as separation, grading and cooling.
4. Block stacking
5. Industrial shelving
6. Storage bins
7. Spill containment

4.18 QUESTIONS AND EXERCISES

Short Answer Questions

1. What are the key material handling equipments?
2. Write a short note on material storage system.
3. Define industrial shelving and industrial scales.
4. Write a short note on spill containment system.
5. Examine the importance of industrial waste disposal.

Long Answer Questions

1. Discuss the role of material handling in logistics.
2. Describe the different types of loading and unloading equipments?
3. Explain the pallet equipments and carrying equipments?
4. Explain storage types and storage unit management.
5. Discuss the scope of material storage system.

UNIT 5 INVENTORY MANAGEMENT

NOTES

Structure

5.0 INTRODUCTION

The term inventory means any stock of direct or indirect material (raw materials or finished items or both) stocked in order to meet the expected and unexpected demand in the future. A basic purpose of inventory management is to control inventory by managing the flows of materials. It sets policies and controls to monitor levels of inventory and determine what levels should be maintained, when stock should be replenished, and how large orders should be.

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5.1 UNIT OBJECTIVES

After going through this unit, you will be able to:

- Explain the meaning, need and functions of inventory management
- Measure the stock levels under the conditions of certainty, risk and uncertainty
- Define EOQ
- Know the key techniques of inventory classification
- Prepare inventory ledger.

5.2 INVENTORY MANAGEMENT

Inventories are materials and supplies carried on hand either for sale or to provide material or supplies to the production process. They provide a buffer against the differences in demand rates and production rates.

Inventory Management involves the control of current assets being procured or produced in the normal course of the company's operations i.e. "how many" parts, pieces, components, raw materials and finished goods the firm should hold and when should it replenish the stock. What should be the trigger points for action?

The purpose of holding inventories is to allow the firm to separate the processes of purchasing, manufacturing, and marketing of its primary products. In other words, the inventory forms a buffer that ensures the flow of the goods and services of the firm is maintained on a continuing basis, based on the customer's requirements.

Inventories not only separate processes, but also reduce risk of production shortages.

For example, manufacturing firms frequently produce goods with hundreds or even thousands of components. If any of these components are not available on time, the entire production operation can be halted. This would mean a heavy loss to the firm.

To avoid starting a production run and then discovering the shortage of a vital raw material or other component, firms maintain inventories.

The goal of effective inventory management is to minimise the total costs – direct and indirect – that are associated with holding these assets. However, the importance of Inventory Management to the company depends upon the extent of investment in inventory. As the value of the inventory goes up, the criticality of the function in Inventory Management enables an organisation to meet or exceed customers' expectations of product availability while maximising net profits or minimising costs.

What is Inventory?

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The term inventory means any stock of direct or indirect material (raw materials or finished items or both) stocked in order to meet the expected and unexpected demand in the future. A basic purpose of inventory management is to control inventory by managing the flows of materials. It sets policies and controls to monitor levels of inventory and determine what levels should be maintained, when stock should be replenished, and how large orders should be.

5.3 NEED OF INVENTORY

Inventory is a stock of materials used to satisfy customer demand or support the production of goods or services. By convention, inventory generally refers to items that contribute to or becomes part of an enterprise's output. There are different types of inventory, however, the most commonly identified types of inventory are:

- Raw Materials Inventory: Parts and raw materials obtained from suppliers that are used in the production process.
- Work-in-process (WIP) Inventory: This constitutes partly-finished parts, components, sub-assemblies or modules that have been started into the production process but not yet finished.
- Finished Goods Inventory: Finished product or end-items.
- Replacement Parts Inventory: Maintenance parts meant to replace other parts in machinery or equipment, either the company's own or that of its customers.
- Supplies Inventory: Parts or materials used to support the production process, but not usually a component of the product.
- Transportation (pipeline) Inventory: Items that are in the distribution system but are in the process of being shipped from suppliers or to customers.

Though the description above focuses on manufacturing inventory, wholesalers and retailers have corresponding inventory types. The different types of inventories are given below and each type has different risks depending upon the firm's position in the distribution channel:

5.4 FUNCTIONS OF INVENTORY

To maintain independence of operations, a supply of materials at a work center allows that center flexibility in operations. Consider the case – an enterprise that does not have any inventory. Clearly, as soon as the enterprise receives a sales order, it will have to order for raw materials to complete the order. This will keep the customers waiting. It is quite possible that sales may be lost. Also, the enterprise may have to pay high price for some other reasons. If the demand for the product is known precisely, it may be possible (though not necessarily economical) to produce the

product to exactly meet the demand. However, in the real world this does not happen and inventories become essential. It is almost essential to keep some inventory in order to promote smooth and efficient running of business.

Inventory comprises physical stock of goods that is kept by an enterprise for future purposes. Functional inventory categories are:

- Working Stock: Also known as 'work-in-progress', is the inventory associated with manufacturing/production. Significant amounts of inventory can be accumulated between processes or at the assembly line.
- Safety Stock: It is the stock that is always kept in store to protect against uncertainties. It is a buffer.
- Anticipation Stock: Stock kept at hand to meet seasonal fluctuations in demand or to meet the shortfall caused by erratic production. Also called build stock or seasonal stock.
- Pipeline Stock: This is stock that is on the books of the firm but is not physically available, e.g. stock in transit.
- Decoupling Stock: Inventory "decouples" in different stages. It might be raw material, WIP, finished goods inventory. Ex: customer has inventory for 10 days for consumption. For 10 days customer is decoupled from producer. So, decoupling inventory is the one which decouples customer and producer.
- Psychic Stock: Used in retail, it is retail display inventory used for stimulating demand.

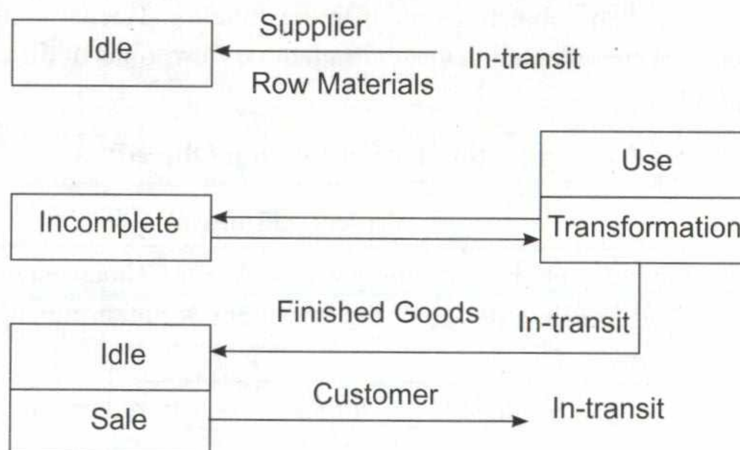


Fig. 5.1: Functions of inventory

Broadly speaking, the functions of inventory have been shown in Figure 5.1. Raw materials flow in from the supplier and finally are sold to the customer. During the process of providing goods to the customer, the inventory is required for use, transformation and for distribution. A part of the inventory is in transit connecting the different transformation and distribution activities.

The build-up of inventory takes place at different points during this flow from the supplier to the final customer. It is desirable to maintain inventories in order to

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provide time utility, guard against discontinuity and uncertainty, enhance stability of production, and protect employment levels and to provide economic advantage to the organisation.

Some of the functions of inventories are:

- To protect against unpredictable variations (fluctuations) in demand and supply;
- To take the advantage of price discounts by bulk purchases;
- To take the advantage of batches and longer production run;
- To provide flexibility to allow changes in production plans in view of changes in demands, etc; and
- To facilitate intermittent production.

Formulating inventory policy requires understanding the inventory's role in the firm. Inventories permit production planning for smoother flow and lowercost operation through larger lot-size production. They allow a buffer when delays occur. These delays can be for a variety of reasons: a normal variation in shipping time, a shortage of material at the vendor's plant, an unexpected strike in any part of the supply chain, a lost order, a climatic catastrophe like a hurricane or floods, or perhaps a shipment of incorrect or defective materials.

In simple terms, inventory is an idle resource of an enterprise comprising physical stock of goods that is kept by an enterprise for future purposes. You do not want to hold it, but cannot do without it.

The inventory decision gets complicated due to the different relationships between inventory and the objectives of different functional departments. These conflicting objectives are reflected in the contradictory viewpoints of different parts of the organisation.

Table 5.1: Conflicting Organisational Objectives

Area	Typical Response
Marketing/ Sales	We can't sell from an empty wagon. We can't keep our customers if we continue to stock-out and there is not sufficient product variety.
Production	If we can produce larger lot sizes, we can reduce per unit cost and function efficiency.
Purchasing	We can reduce the per unit cost, if we buy large quantities in bulk.
Warehousing	We are out of space. We can't fit anything else in the building.
Finance	Where are we going to get the funds to pay for the inventory? The levels should be lower.

These comments in Table 5.1 place the focus on the functional significance of inventory for different departments in the organisation.

Marketing would like to have a large inventory so that customer service can be improved and sales can increase. Production would like to minimise set-up costs and increase worker productivity by having large production runs adding on to the in-process inventory (work-in-progress and finished goods).

Purchasing can bring down prices by buying in bulk and obtaining quantity discounts. Stores or warehousing has storage constraints in storing and moving large quantities of stock. But the bottom line is equally important. All these requirements can be met at a cost. Larger inventories mean more capital investment, lower cash flows, idle inventory, and lower profitability. This is reflected in the comments made by Finance.

All this is clearly seen below in Table 5.2. The whole picture of the inventory becomes clear when seen in the context of the different functional objectives of departments within the organisation.

Table 5.2: Functional Significance of Inventory

Functional Area	Functional Responsibility	Inventory Goal	Inventory Inclination
Marketing	Sell the product	Maximise customer service	High
Production	Make the product	Efficient lot sizes	High
Purchasing	Buy required materials	Low cost per unit	High
Finance	Provide working capital	Efficient use of capital	Low
Engineering	Design the product	Avoid obsolescence	Low

As will be apparent from Table 5.2, some functional areas find inventory desirable, while others do not. What is important to note is that both the inclination to hold inventory and the inventory goals of the different functions are significantly different.

For example, inventory can be used to promote sales by reducing customer's waiting time, improve work performance by reducing the number of setups, or protect employment levels by minimising the cost of changing the rate of production. Therefore, it is desirable to maintain inventories in order to enhance stability of production and employment levels.

The functionality of inventory becomes clear only when it is considered in light of all quality, customer service and economic factors—from the viewpoints of purchasing, manufacturing, sales and finance. Inventory build-up is important as it is meant to permit them to meet their functional objectives.

The major issue in inventory decisions is how to reconcile the differences between the different functional requirements of the different parts of the organisation and the goals of the organisation as a whole. No matter what the viewpoint of each

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department is or what each function desires, in the ultimate analysis; effective inventory management has to provide an economic advantage that is essential to organisational competitiveness.

A significant percentage of assets of many firms are tied-up in inventories. This could range from fifteen per cent to nearly fifty percent of the capital utilised in a typical firm. Holding of inventory, therefore, reflects a type of risk to the firm, these are risks related to the capital investment and the potential for obsolescence of the inventory.

For the manufacturer, inventory risk has a long-term dimension. Although retailers or wholesalers have a wider product line than the manufacturer, the manufacturer's inventory commitment is relatively deep and of long duration. Wholesaler risk exposure is narrower but deeper and of longer duration than that of retailers. Although retailers assume a position of risk on a variety of products, the position on any product is not deep. This does not mean that their risk is lesser; due to the variety of merchandise the risk is wider. For example, a typical supermarket carries more than 10,000 SKUs. This variety of merchandise reflects the risk of the retailer. If an individual enterprise plans to operate at more than one level of the distribution channel, it must be prepared to assume additional inventory risk.

Only when considered in light of all quality, customer service and economic factors – from the viewpoints of purchasing, manufacturing, sales and finance – does the whole picture of inventory functionality become clear. No matter what the viewpoint, effective inventory management is essential to organisational competitiveness as excessive inventory is a drain to the profitability of the organisation.

5.5 STOCK LEVELS UNDER CONDITIONS OF CERTAINTY, RISK AND UNCERTAINTY

As discussed earlier, the reorder point determines when a re-supply shipment should be initiated. The reorder point, which is defined by item and distribution center, can be specified in terms of units or days of supply.

This discussion focuses on determining reorder points under conditions of demand and performance-cycle certainty. The certainty conditions imply that future demands and performance-cycle lengths are known.

The basic reorder point formula is:

$$R = D \times T$$

Where, R = reorder point in units

D = average daily demand

T = average performance-cycle length

To illustrate this calculation, assume demand of 10 units/day and a 20-day performance cycle. In this case,

$$= 10 \text{ units/day} \times 20 \text{ days} = 200 \text{ units}$$

The use of the reorder point formulations discussed above implies that the resupply shipment will arrive just as the last unit is shipped to a customer. This approach is satisfactory as long as both demand and performance cycles are certain. When there is uncertainty in either demand or performance-cycle length, an inventory buffer is necessary to compensate for the uncertainty. The buffer, which is usually called safety stock, handles customer demands during longer than expected performance cycles or above average daily demand. When this buffer stock is necessary for conditions of uncertainty, the reorder point formula is:

$$R = D \times T + S_S$$

Where, R = reorder point in units

D = average daily demand

T = average performance-cycle length

S_S = safety or buffer stock in units

Inventory Model with Uncertainty

Inventory models with uncertainty have been developed that can be used to determine how much inventory should be kept on stock, what service levels should be met, and how to design inventory layout. Such models consider that risks have geometrically-distributed probabilities and demand to be either deterministic or normally distributed.

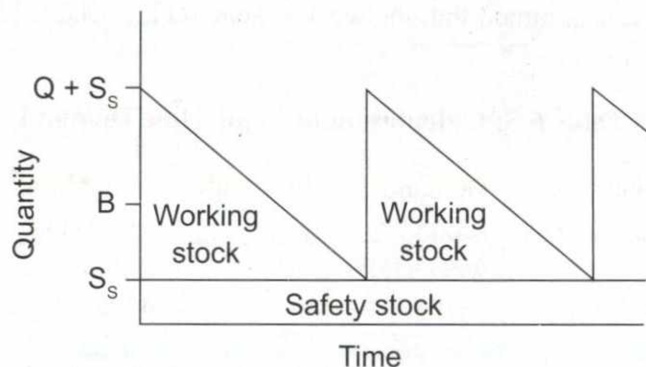


Fig. 5.2: Working stock and safety stock

Figure 5.2 shows the relationship between working stock and safety stock, where the demand is uncertain. In the Figure S_s represents the safety stock. B is the reorder point and the working stock is shown as the difference between the total stock and safety stock.

In re-order point models with risk, the probability distribution of demand during the lead-time is an important characteristic in inventory management. We can, generally, assume the lead time demand as a normal distribution as shown in Figure 5.3. The 'Y' axis shows the frequency of occurrence i.e. the probability, and the 'X' axis shows the demand during the lead time.

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The reason that we can represent the inventory model with the distribution is because of the central limit theorem. Suppose we repeat an experiment many times, where the lead time demand is 'M', and 'M_i' is the result of the ith experiment. In general, we won't know what the distribution of 'M_i' is, and it may be discrete or continuous. The central limit theorem says that the distribution of the average of the M_i's is normal.

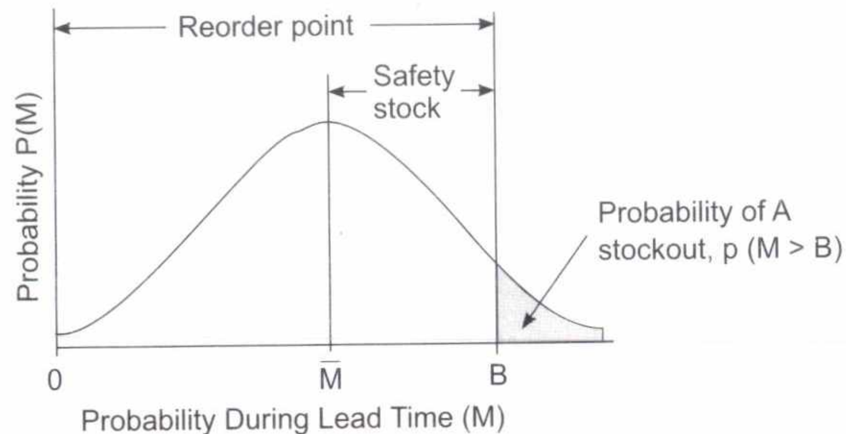


Fig. 5.3: Realistic lead time demand

Using these concepts, we can tackle problems with constant lead time and variable demand. Data has been provided in Table 5.3 to illustrate such a problem. In the problem, it is assumed that the weekly demand is variable and the lead time is constant at two weeks.

Table 5.3: Calculation of Lead Time Demand

Demand first week (D)	Probability p(D)	Demand second week (D)	Probability p(D)	Lead time demand (col. 1) (col. 3) (M)	Probability (col. 2) (col. 4) p(M)
1.	0.60	1	0.60	2	0.36
		3	0.30	4	0.18
		4	0.10	5	0.06
2.	0.30	1	0.60	4	0.18
		3	0.30	6	0.09
		4	0.10	7	0.03
3.	0.10	1	0.60	5	0.06
		3	0.30	7	0.03
		4	0.10	8	0.01

The basic data in Table 5.3, in columns 1 to 3 are used to calculate the lead time demand and the probability of lead time demand, which are given in columns 5 and 6. The lead time demand obtained and the probability of lead time demand obtained in Table 5.3 have been rearranged in Table 5.4 to obtain the distribution.

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Table 5.4: Lead Time Demand and Probability

Lead time demand (M)	Probability P(M)
0	0
1	0
2	0.36
3	0
4	0.36
5	0.12
6	0.09
7	0.06
8	0.01
Total	1.00

We have worked out the example of constant lead time and variable demand above.

A reasonable approximation method for determining model parameters is to use the EOQ model to solve for the order size. The time between orders is then simply the order quantity divided by annual demand. The standard deviation of demand during the order interval is found by determining the daily standard deviation of demand and multiplying by the square root of the length of the order interval. Different relationships emerge when there is:

(a) Variable demand and constant lead time,

(b) Constant demand with variable lead time, and

(c) Variable demand with variable lead time

Each of these relationships is shown below. The notations that are used are as follows:

'B' = Reorder point in units.

'M' = Lead time demand in units (a random variable).

'F (M)' = Probability density function of lead time demand.

'P (M)' = Probability of a lead time demand of M units.

'L' = Expected lead time

'Lm' = Maximum lead time

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'σ'	=	Standard deviation of lead time demand
'Q'	=	Lot size
'S'	=	Set-up cost or Ordering Cost (₹ /year)
'S_S'	=	Safety Stock
'D'	=	Annual Demand
'P'	=	Unit Price (₹ /unit)
'H'	=	Holding or Carrying cost per Unit (₹ /Unit)
'F'	=	Inventory Carrying Charges Factor
'Q*'	=	Economic Order quantity (to be determined)

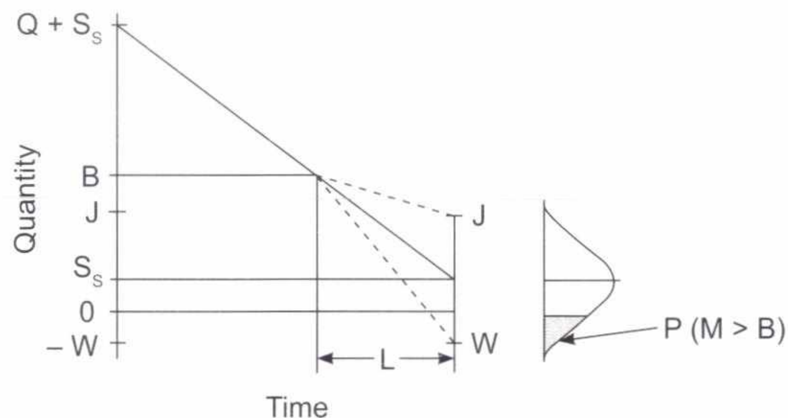


Fig. 5.4: Inventory risk: variable demand and constant lead time

The relationships that emerge when Demand is variable and Lead Time is constant are shown in Figure 5.4. The figure shows the relationships that are given below:

$B - S_S$	=	expected lead time demand
$B - J$	=	minimum lead time demand
$B + W$	=	maximum lead time demand
$P(M>B)$	=	probability of a stock-out

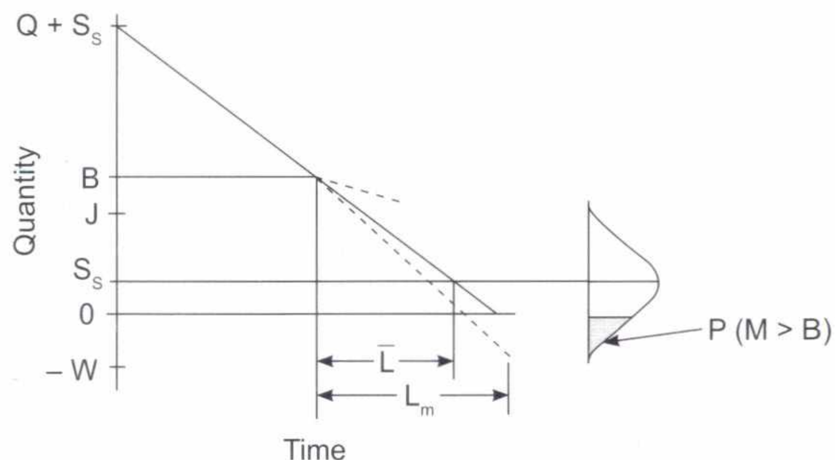


Fig. 5.5: Inventory risk: variable demand and variable lead time

The relationships when there is constant demand with variable lead time are shown in Figure 5.5. The relationships that emerge from this configuration are given below:

P (M > B) = probability of a stock-out

B – S = expected lead time demand

B + W = maximum lead time demand

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The lot order size is given by the expression:

$$Q^* = \sqrt{2DS / H} \quad \ldots (1)$$

And the reorder point is given by:

$$B = M + S_s \quad \ldots (2)$$

When both demand and lead times are probabilistic, the basic procedure for finding operating doctrines is a convergence procedure. This is a directed trial an error method. For the quantity/reorder point model, the order quantity is computed assuming constant demand. Then the reorder point is calculated using the computed order quantity. This value is then used to recalculate the order quantity and recalculate the reorder point. Eventually, the order quantity and the reorder point coverage to their optimal values. The example of ABC Ltd. illustrates the method.

ABC Ltd. for one of its class 'A' items, has an ordering cost of ₹ 5,400.00, the inventory holding cost is 40 percent, and the cost per unit is ₹ 40.00.

'D' = Annual demand = 8 × 150 = 1200 units

'P' = Unit purchase cost = ₹ 40.00

'S' = Ordering Cost = ₹ 5400.00

'F' = Holding Cost = 40%

The lead time to deliver the item is 10 days. The lead time demand is given in the table below.

Table. 5.5 Lead Time Demand Vs Probability

Lead time demand (M)	Probability P(M)	Lead time demand (M)	Probability P(M)
0	0	1	0
2	0.36	3	0
4	0.36	5	0.12
6	0.09	7	0.06
8	0.01	Total	1.00

What is the lowest cost reorder point if the stock-out cost is ₹ 5 per unit?

Using the Economic Order Equation:

$$Q^* = \sqrt{(2DS/H)} = \sqrt{(2DS/FP)} = EOQ$$

$$= (2 \times 5400 \times 1200) / (0.40 \times 40) = 900 \text{ units.}$$

NOTES

Reorder Level: $R_B = L \times D = (10/365) \times 1200 \approx 33$ units

Let us now determine the lowest cost reorder point.

$$B = 34 \ E(M > B) = \sum_{M=B+1}^{M_{max}} (M - B)p(M) \text{ or } \sum_{1+1}^{8}(M-33)p(M)$$

$$= (34 - 33) \times 0.36 + (34 - 33) \times 0.00 + (34 - 33) \times 0.36 + (34 - 33) \times 0.12 + (34 - 33) \times 0.09 + (34 - 33) \times 0.06 + (34 - 33) \times 0.01$$

$= 1$ unit

TC_S = Holding Cost + Stock-out Cost

$= (B - M) H + SC_S \ E(M > B)/Q$

$TC_S = (34 - 33) \times 1 + 5400 \times 2 \times 1/900$

$= 1 + 12 =$ ₹ 13.00

$$B = 35 \ E(M > B) = \sum_{2+1}^{8}(M-33)p(M)$$

$$= (35 - 33) \times 0.36 + (35 - 33) \times 0.12 + (35 - 33) \times 0.09 + (35 - 33) \times 0.06 + (35 - 33) \times 0.01$$

$= 1.28$ units

$TC_S = (35 - 33) \times 1 + 5400 \times 2 \times 1.28/ 900$

$= 2 + 15.36 =$ ₹ 17.36

$$B = 36 \quad E(M > B) = \sum_{4+1}^{8}(M-33)p(M)$$

$$= (36 - 33) \times 0.12 + (36 - 33) \times 0.09 + (36 - 33) \times 0.06 + (36 - 33) \times 0.01$$

$= 1.12$ units

$TC_S = (36 - 33) \times 1 + 5400 \times 2 \times 1.12/ 900$

$= 4 + 13.44 =$ ₹ 17.44

$$B = 37 \ E(M > B) = \sum_{5+1}^{8}(M-33)p(M)$$

$$= (37 - 33) \times 0.09 + (37 - 33) \times 0.06 + (37 - 33) \times 0.01$$

$= 0.80$ units

$TC_S = (37 - 33) \times 1 + 5400 \times 2 \times 0.80/ 900$

$= 5 + 9.60 =$ ₹ 14.60

$$B = 38 \ E(M > B) = \sum_{6+1}^{8}(M-33)p(M)$$

$$= (38 - 33) \times 0.06 + (38 - 33) \times 0.01$$

$= 0.42$ units

$$TC_S = (38 - 33) \times 1 + 5400 \times 2 \times 0.42/ 900$$
$$= 6 + 5.04 = ₹ 11.04$$

$$B = 39\ E(M > B) = \sum_{7+1}^{8} (M - 33)p(M)$$
$$= (39 - 33) \times 0.01$$
$$= 0.07 \text{ units}$$
$$TC_S = (39 - 33) \times 1 + 5400 \times 2 \times 0.07/ 900$$
$$= 7 + 0.84 = ₹ 7.84$$

Therefore, the lowest cost of reorder point is 39 units with an expected annual cost of safety stock of ₹ 7.84.

In the example that we worked out above and in this section, we have considered the single period inventory problem when there is a fixed order or setup cost including the point at which the marginal revenue of an additional unit of initial inventory just equals the marginal cost of a unit of inventory.

5.6 COST OF CARRYING AND NOT HOLDING ADEQUATE INVENTORY

The heart of inventory decisions lies in the identification of inventory costs and optimising the costs relative to the operations of the organisation. Therefore, an analysis of inventory is useful to determine the level of stocks. The resultant stock keeping decision specifies:

1. When items should be ordered, and
2. How large the order should be
3. "When" and "how many to deliver."

It must be remembered that inventory is costly and large amounts are generally undesirable. Inventory can have a significant impact on both a company's productivity and its delivery time. Large holdings of inventory also cause long cycle times which may not be desirable as well. What are the costs identified with inventory?

The costs generally associated with inventories are shown in Figure. 5.6. The different components of cost are discussed as follows:

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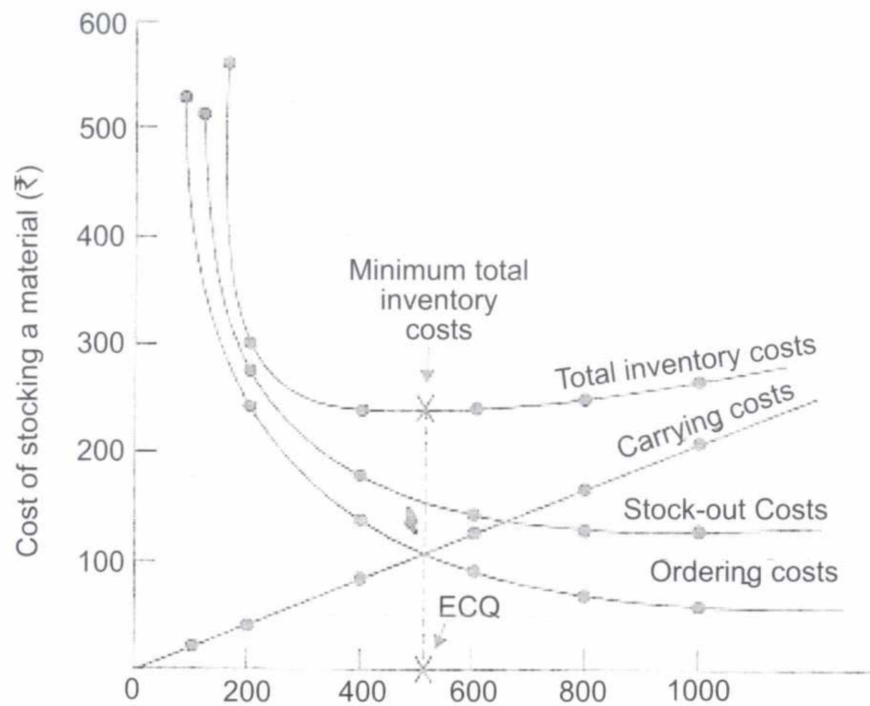


Fig. 5.6: Total inventory costs

Holding (or Carrying) Costs

It costs money to hold inventory. Such costs are called inventory holding costs or carrying costs. This broad category includes the costs for storage facilities, handling, insurance, pilferage, breakage, obsolescence, depreciation, taxes, and the opportunity cost of capital. Obviously, high holding costs tend to favour low inventory levels and frequent replenishment.

There is a differentiation between fixed and variable costs of holding inventory. Some of the costs will not change by increase or decrease in inventory levels, while some costs are dependent on the levels of inventory held. The general break down for inventory holding costs has been shown in Table.

Table 5.6: Fixed and Variable Holding Costs

Fixed Costs	Variable Costs
Capital costs of warehouse or store	Cost of capital in inventory
Cost of operating the warehouse or store	Insurance on inventory value
Personnel costs	Losses due to obsolescence, theft, spoilage
	Cost of renting warehouse or storage space

NOTES

Cost of Ordering

Although it costs money to hold inventory, it also, unfortunately, costs to replenish inventory. These costs are called inventory ordering costs. Ordering costs have two components:

- One component that is relatively fixed, and
- Another component that will vary.

It is good to be able to clearly differentiate between those ordering costs that do not change much and those that are incurred each time an order is placed. The general breakdown between fixed and variable ordering costs is as follows:

Table 5.7: Fixed and Variable Ordering Costs

Fixed Costs	Variable Costs
Staffing costs (payroll, benefits, etc.)	Shipping costs
Fixed costs on IT systems	Cost of placing and order (phone, postage, order forms)
Office rental and equipment costs	Running costs of IT systems
Fixed costs of vendor development	Receiving and inspection costs
	Variable costs of vendor development

One major component of cost associated with inventory is the cost of replenishing it. If a part or raw material is ordered from outside suppliers, and places orders for a given part with its supplier three times per year instead of six times per year, the costs to the organisation that would change are the variable costs, and which would probably not be the fixed costs.

There are costs incurred in maintaining and updating the information system, developing vendors, and evaluating capabilities of vendors. Ordering costs also include all the details, such as counting items and calculating order quantities. The costs associated with maintaining the system needed to track orders are also included in ordering costs. This includes phone calls, typing, postage, and so on.

Though vendor development is an ongoing process, it is also a very expensive process. With a good vendor base, it is possible to enter into longer-term relationships to supply needs for perhaps the entire year. This changes the "when" to "how many to order" and brings about a reduction both in the complexity and costs of ordering.

5.7 EOQ (ECONOMIC ORDER QUANTITY)

The economic order quantity (EOQ) is the replenishment order quantity that minimises the combined cost of inventory maintenance and ordering. Identification of such a quantity assumes that demand and costs are relatively stable throughout the year. Since an EOQ is calculated on an individual product basis, the basic formulation

NOTES

does not consider the impact of joint ordering of products. EOQ extensions are discussed later in this unit.

The most efficient method for calculating economic order quantity is mathematical.

A policy dilemma regarding whether to order 100, 200, or 600 units arises in this situation. The answer can be found by calculating the applicable EOQ for the situation.

To make the appropriate calculations, the standard formulation for EOQ is

$$EOQ = \sqrt{\frac{2C_0D}{C_iU}}$$

Where, EOQ = Economic Order Quantity

C_0 = cost per order

C_i = annual inventory carrying cost per unit

D = annual sales volume, units

U = cost per unit

Table 5.8: Factors for Determining EOQ

Annual Demand Volume	2,400 units
Unit value at cost	₹ 5
Inventory carrying cost percentage	20% annually
Ordering cost	₹ 19 per order

Thus, $EOQ = \sqrt{\frac{2 \times 19 \times 2400}{0.20 \times 5}}$

$= \sqrt{91,200}$

= 302 (rounded of to 300)

Total ordering cost would amount to ₹ 152 (2400/300 × ₹ 19) and maintenance cost ₹ 150 [300/2 × (5 × 0.20)]. Thus, after rounding to allow ordering in multiples of 100 units, annual reordering and maintenance costs have been equated.

To benefit from the most economical purchase arrangement, orders should be placed in the quantity of 300 units rather than 100, 200, or 600. Thus, over the year, eight orders would be placed, and average base inventory would be 150 units. An EOQ of 300 implies that additional inventory in the form of base stock has been introduced into the system. Average inventory has been increased from 100 to 150 units on hand.

While the EOQ model determines the optimal replenishment quantity, it does require some rather stringent assumptions that constrain its direct application. The major assumptions of the simple EOQ model are:

- Satisfaction of all demand
- Continuous, constant, and known rate of demand
- Constant and known replenishment performance-cycle time
- Constant price of product that is independent of order quantity or time (i.e., no purchase quantity or transportation price discounts are available)
- Infinite planning horizon
- No interaction between multiple items of inventory
- No inventory in transit
- No limit on capital availability. The constraints imposed by some of these assumptions can be overcome through computational extensions, as discussed next. However, the EOQ concept illustrates the importance of the trade-offs associated with holding and acquisition cost.

EOQ Extensions

While the EOQ formulation is relatively straightforward; there are some other factors that must be considered in actual application. The most persistent problems are those related to various adjustments necessary to take advantage of special purchase situations and unitisation characteristics.

Three typical adjustments are volume transportation rates, quantity discounts, and other adjustments. These are discussed as follows:

Volume Transportation Rates

In the EOQ formulation discussed previously, no consideration was given to the impact of transportation cost on order quantity. When products are purchased on a delivered basis and the seller pays transportation cost from origin to the inventory destination, such neglect may be justified. The seller is responsible for the shipment until it arrives at the customer's place of business. However, when product ownership is transferred at origin, the impact of transportation rates on total cost must be considered when determining order quantity.

As a general rule, the greater the weight of an order, the lower is the cost per pound of transportation from any origin to destination. A freight-rate discount for larger-size shipments is common for both truck and rail and is found in most transportation rate structures. Thus, all other things being equal, an enterprise naturally wants to purchase in quantities that maximise transportation economies. Such quantities may be larger than the purchase quantity determined using the EOQ method. Increasing order size has a two-fold impact on inventory cost. Assume for purposes of illustration that the most desirable transportation rate is obtained when a quantity of 480 is ordered as compared to the EOQ-recommended order of 300 calculated earlier. The first impact of the larger order is to increase the average base inventory from 150 to 240 units. Thus, ordering in larger quantities increases inventory carrying cost.

The second impact is a decrease in the number of orders required. The decreased number of orders increases the shipment size, which provides better transportation economies.

To complete the analysis, it is necessary to formulate the total cost with and without transportation savings. While this calculation can be directly made by modification of the EOQ formulation, comparison provides a more insightful answer. The only additional data required are the applicable freight rates for ordering in quantities of 300 and 480. Table 5.9 given below provides the data necessary to complete the analysis.

Table 5.9: EOQ Data Requirement for Transportation

Annual Demand volume	2400 units
Unit value at cost	₹ 5
Inventory carrying cost % age	20% annually
Ordering cost	₹ 19 per order
Small shipment rate	₹ 1.00 per unit
Large shipment rate	₹ 0.75 per unit

The second impact is a decrease in the number of orders required. The decreased number of orders increases the shipment size, which provides better transportation economies.

To complete the analysis, it is necessary to formulate the total cost with and without transportation savings. While this calculation can be directly made by modification of the EOQ formulation, comparison provides a more insightful answer. The only additional data required are the applicable freight rates for ordering in quantities of 300 and 480.

Table 5.10 provides the analysis of total cost. Taking into consideration the potential transportation savings by purchasing in larger lot sizes, the total annual cost, by purchasing 480 units five times per year rather than the EOQ solution of 300 units eight times per year, results in approximately 570 savings.

The impact of volume transportation rates on total cost of procurement cannot be neglected. In the example above, the equivalent rate per unit dropped from ₹ 1 to ₹ 0.75, or by 25 percent. The cost-per-hundred weight range from minimum weight LTL to carload minimum weight may significantly exceed this 25 percent figure. Thus, any EOQ must be tested for transportation cost sensitivity across a range of weight breaks if transportation expenses are the buyer's responsibility.

A second point illustrated in the data of Table 5.10 is the fact that rather substantial changes in the size of an order and the number of orders placed per year resulted in only a modest change in the total cost of maintenance and ordering. The EOQ quantity of 300 had a total annual cost of ₹ 302, whereas the revised order

quantity had a comparative cost of ₹335. EOQ formulations are much more sensitive to significant changes in order cycle or frequency. Likewise, substantial changes in cost factors are necessary to significantly affect the economic order quantity.

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Table 5.10: Volume Transportation Rate Modified EOQ

	Alternative 1: q = 300	Alternative 2: q = 480
Inventory carrying cost	150	240
Ordering cost	152	95
Transportation cost	2,400	1,800
Total Cost	2,702	2,135

Finally, two factors regarding inventory cost under conditions of origin purchase are noteworthy. Origin purchase means that the buyer is responsible for freight cost and product risk when the product is in transit. First, the buyer assumes full risk on inventory at the time of shipment. Depending on time of required payment, this could mean that transit inventory is part of the enterprise's average inventory and therefore subjected to an appropriate charge. It follows that any change in weight break leading to a shipment method with a different in-transit time should be assessed as the added cost or savings as appropriate in a total cost analysis.

Second, the transportation cost must be added to the purchase price to obtain an accurate assessment of the value of goods tied up in inventory. Once the inventory has been received, the amount invested in the product must be increased by the transportation expenses. Inventory carrying cost should then be assessed on the combined cost of the item plus transportation.

Quantity Discounts

Purchase quantity discounts represent an EOQ extension analogous to volume transportation rates. Table 5.11 illustrates a sample schedule of discounts.

Table 5.11: Quantity Discounts

Cost ₹	Quantity Purchased
5.00	1-99
4.50	100-200
4.00	201-300
3.50	301-400
3.00	401-500

Quantity discounts can be handled directly with the basic EOQ formulation by calculating total cost at any given volume-related purchase price to determine

Check Your Progress

1. Define inventory management.
2. What do you know about WIP inventory?
3. What is safety stock?
4. Define the meaning of anticipation stock.

associated EOQs. If the discount at any associated quantity is sufficient to offset the added cost of maintenance less the reduced cost of ordering, then the quantity discount offers a viable alternative. It should be noted that quantity discounts and volume transportation rates each affect larger purchase quantities. This does not necessarily mean that the lowest total cost purchase will always be a larger quantity than would otherwise be the case under basic EOQ.

Other EOQ Adjustments

A variety of special situations may occur that will require adjustments to the basic EOQ. Examples are: (1) production lot size, (2) multiple item purchase, (3) limited capital, and (4) private trucking. Production lot size refers to the most economical quantities from a manufacturing perspective. Multiple item purchase describes situations when more than one product is bought concurrently, so that quantity and transportation discounts must consider the impact of product combinations. Limited capital refers to situations with budget limitations for total inventory investment. Since the product line must be satisfied within the budget limitations, order quantities must recognise the need to allocate the inventory investment across the product line. Private trucking influences order quantity since it represents a fixed cost once the decision is made to replenish a product. If it is decided to use a private fleet to transport a replenishment product, the enterprise should fill the truck regardless of the EOQ. It does not make sense to transport a half-empty truck simply so that the order quantity represents the EOQ.

Another consideration when establishing the order quantity is the unitization characteristic. Many products are stored and moved in standard units such as cases or pallets. Since these standardized units are designed to fit transportation or handling vehicles, there may be significant diseconomies when the EOQ is not a unit multiple. As an example, suppose that a pallet can hold 200 units of a specified product. Using an EOQ of 300 units would imply shipments of 1.5 pallets. From a handling or transportation utilization perspective, it is probably more effective to order one or two pallets either alternatively or permanently. Standard unit multiples should be considered when determining EOQ.

5.8 STOCK-OUT COST-BASED INVENTORY DECISIONS

When the stock of an item is depleted, an order for that item must either wait until the stock is replenished or be cancelled. There is a trade-off between carrying stock to satisfy demand and the costs resulting from stock-out. The costs that are incurred as a result of running out of stock are known as stock-out or shortage costs. As a result of shortages, production as well as capacity can be lost, sales of goods may be lost, and finally customers can be lost.

In manufacturing, inventory requirements are primarily derived from dependent demand, however, in retailing the requirements are basically dependent on independent demand. Inventory systems are predicted on whether demand is derived from an end item or is related to the item itself. Because independent demand is uncertain extra inventory needs to be carried to reduce the risk of stocking out. To determine the quantities of independent item that must be produced, firms usually use a variety of techniques, including customer surveys, and forecasting. However, a balance is sometimes difficult to obtain, because it may not be possible to estimate lost profits, the effects of lost customers, or lateness penalties.

If the unfulfilled demand for the items can be satisfied at a later date (back order case), in this case cost of back orders are assumed to vary directly with the shortage quantity (in rupee value) and the cost involved in the additional time required to fulfil the back order (`/year). However, if the unfulfilled demand is lost, the cost of shortages is assumed to vary directly with the shortage quantity (unit shortage). Frequently, the assumed shortage cost is little more than a guess, although it is usually possible to specify a range of such costs.

5.9 INVENTORY CLASSIFICATION

It is useful to visualize the inventory of a medium-sized business organization.

The inventory would comprise thousands of items, each item with different usage, price, lead time and specifications. This makes the planning and co-ordination very difficult if not impossible. There could be different procurement and technical problems associated with different items and many a time the firm has to deal with the inability of the entire chain of suppliers to respond promptly.

As the number of departments and users increase different types of issues arise.

For example, an electric company had as many as 118 names for a simple screw with a width of 3/8 inches and length of 6 inches, depending upon the type of usage and the department using the screw. This type of issue would finally result in confusion and tend to duplicate ordering or result in overstocking.

In order to escape this quagmire many selective inventory management techniques are used based on thorough analysis of the items that constitute the inventory. It is often prudent to classify inventory so as to improve response time and bring the relevant issues within the capability of the supply chain partners.

The use of class systems make the effort to manage inventory more effective and efficient than if the organization managed each individual item independently. Some of the classifications that facilitate this process of improving the management of inventory are described as follows.

NOTES

5.9.1 ABC Classification

ABC classification, or the alphabetical approach, is based on the annual consumption value. Typically, only 20 percent of all the items account for 70 to 80 percent of the total rupee usage, while the remaining 80 percent of the items, typically account for remaining 20 to 30 percent of the rupee value. The ABC classification is based on focusing efforts where the payoff is highest; i.e. high-value, high-usage items must be tracked carefully and continuously. As these items constitute only 20 percent, the ABC analysis makes the task relatively easier.

After calculating the rupee usage for each inventory item, the items are ranked by rupee usage, from highest to lowest. The first 20 percent of the items are assigned to class 'A'. These are the items that warrant closest control and monitoring through a perpetual inventory system.

One of the major costs of inventory is annual carrying costs, and your money is invested largely in class 'A'. Tight control, sound operating doctrine, and attention to security on these items would allow you to control a large rupee volume with a reasonable amount of time and effort.

The next 30 percent of the items are classified as 'B' items. These deserve less attention than 'A' items. Finally, the last 50 percent of items are 'C' items. These have the lowest rupee usage and can be monitored loosely, with larger safety stocks maintained to avoid stock-outs. They should have carefully established but routine controls.

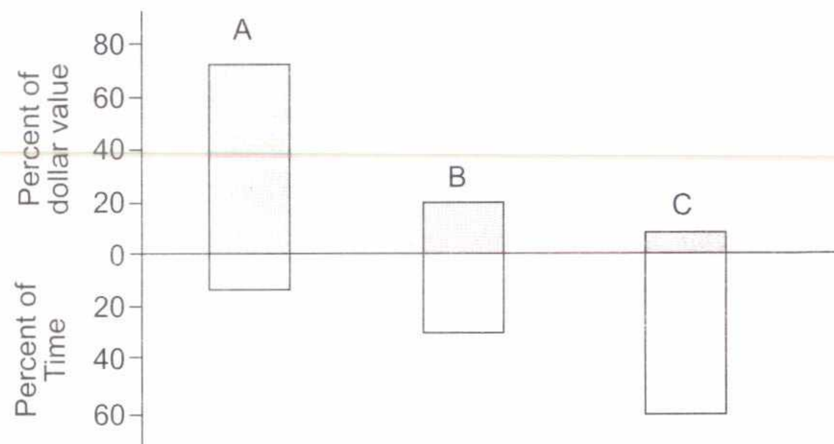


Fig. 5.7: ABC Analysis

This classification is commonly used by companies, as very often they need not keep extremely accurate track of all inventory items. Through performing 80/20 analysis, many companies are optimizing their investment in inventory, and production, procurement and distribution assets. These companies are able to analyze their inventory network as well as policies and able to add inventory where there are opportunities for winning additional market share and reduce inventory where they are not needed. They do not trim inventories across the board to reduce cost.

Through this approach, organizations are able to increase their overall customer service levels while simultaneously reducing their total inventory carrying costs. Thus these companies are able to improve other key metrics like customer retention, gross margin and inventory turns.

NOTES

The importance of each item is determined while procuring and storing it to improve the purchase efficiency. The fundamental idea behind selective control techniques is to put the efforts where the results are worth it. Even if an organization uses millions of items, only a few items become important—from the finance view, availability considerations, seasonality, criticality of performance, etc. The materials are classified according to their importance and increased attention is paid to the items that are more important. For instance, high-value, high-usage items must be tracked carefully and continuously but certain parts with a relatively low value or infrequent use can be monitored loosely.

The ABC analysis is also a guide to physical count of items of inventory. Counts are conducted depending on the importance of inventory items. 'A' items are counted frequently, 'B' items less frequently and 'C' items are counted the least frequently. Accuracy of the count also depends on the classification. APICS recommends ± 0.2 percent for 'A' items, ± 1 percent for 'B' items and ± 5 percent for 'C' items.

However, ABC analysis should be used prudently. It cannot always be applied across the board. Some categories of items where the application of ABC analysis is fraught with high risk are identified below:

- Difficult Procurement Items
- Short Shelf Life
- Large Storage Space Requirements
- Item's Operational Criticality
- Likelihood of Theft
- Difficult Forecast Items

5.9.2 VED Analysis

Certain items are important by their absence and not by their presence. If not available, they can cause a hold-up in production and result in high costs, shut down or slowdown of production. These items may or may not be priced high but their stock-out costs are indeed very high. These items are called the "vital" items. The "E" stands for "essential" Although these items are not very critical to production; their stock-outs are still expensive. The "D" stands for "desirable" – it is better to avoid stock-outs for these items, although a stock-out for a short period will not affect the production.

This classification is essentially done on the basis of shortage costs of the material.

Various forms of VED classification exist. James A.G. Krupp, Director of Corporate Materials at Echlin Inc had classified the materials in his organization according to its service or operating importance on a three-point scale:

1. Critical
2. Medium
3. Non-critical

All the items in the inventory would fall in 1, 2 or 3 scales.

5.9.3 FSN Analysis

Items can also be classified as fast moving, slow moving or non-moving based on their pattern of issue from the stores. This denotes how soon a material is consumed after it has been purchased and taken into stock. This classification helps in controlling obsolescence.

Items that are very fast moving and are used once in every week or say, every month are classified as "F". Items which are not consumed even once in say two or three years are classified as non-moving—"N". Keeping too many non-moving items in the inventory is dangerous. They block useful working capital and eat into the profitability of the company. Attention needs to be paid to them to declare them as surplus or obsolete and find alternate uses of the material or else dispose them off, so that it leads to money realization as well as space saving.

All items which are neither "fast" nor "non-moving" are termed as "slow Moving" items.

This classification is again of great importance to companies who need to keep a check on where their money is spent.

5.9.4 Other Models

The ABC classification has limitations when applied to items that are scarce, where lead time analysis is difficult and purchasing strategies can be critical. Purchase strategies can also be critical for a number of items that may have to be imported and in addition to normal transportation times, time required for clearance through customs may not be highly predictable. In such cases, there is a tendency to hold too little inventory for items with lumpy demand and too much for items with steady demand.

However, organizations deal with a large number of items with varying degrees of characteristics in terms of size, shape, physical characteristics, sources of supply, modes of handling, user departments, etc. Inventory can also be classified using any of differences between the items.

Items may belong to more than one class depending upon the criteria used. Any of these criteria could be the basis of classification. The criterion could be the nature of the materials, e.g. raw materials, machinery and equipment, consumable items, chemicals, packaging materials, inflammable items, fuel stock, furniture and fixtures, scrap, general materials etc. Another could be, on the basis of usability of the material e.g. finished, semi-finished items, dead stock items, unused items,

serviceable, unserviceable, and dead stock items, etc. Still another criterion could be the critically of the component, e.g. vital, essential, desirable, etc.

There are, therefore, a number of classification systems besides the ABC classification that are used in industry. Most of these systems operate in a similar manner to the ABC classification. A brief description and comparison of these classifications are given in Table. 5.12

NOTES

Table 5.12: Comparison of Different Classification Systems

S. No.	Title	Basis	Main Uses
1.	ABC (Level of Usage)	Value of consumption	To control raw material components and work-in-progress inventories in the normal course of business
2.	HML (High, medium, low usage)	Unit price of the material	Mainly to control purchase
3.	FSND (fast moving, slow moving, non-moving, dead items)	Consumption pattern of the component	To control obsolescence
4.	SDE (scarce, difficult, easy to obtain items)	Problems faced in procurement	Lead time analysis and purchasing strategies
5.	Golf (Government, ordinary, local, foreign sources)	Source of the material	Procurement strategies
6.	VED (vital, essential, desirable)	Criticality of the component	To determine the stocking levels of spare parts
7.	SOS (Seasonal, off-seasonal)	Nature of suppliers	Procurement/ holding strategies for seasonal items like agriculture products
8.	XYZ (value of stock)	Value of items in storage	To review the inventories and their use scheduled intervals

Other similar types of classifications are the XYZ classification, VED classification, and the HML classification of inventory. The basic difference between the ABC classification and the XYZ classification is that it is based on the inventory in stock rather than usage.

NOTES

The VED classification is based on the criticality of the inventory item. In normal practice, items in the 'V' category are often monitored manually; in addition to the computer monitoring that may be in place. The HML reflects a classification based on the unit price of the item. Obviously, the 'H' category items require additional attention, especially if the lead times are long, as it may often be in imported components. The 'time' triggered reorder system has some advantages in production cycling, in such high value items.

All these techniques are used to focus management attention in deciding on the degree of control necessary for different items in the inventory. However, it should be kept in mind that changes in the business environment, e.g. customer demand patterns or material costs, can cause material item classifications to change. This in turn can affect key planning and scheduling decisions.

1. XYZ Analysis

This classification is based on the stock value of the items. Items having a very high stock value are classified as 'X'. Items with least stock value are classified as "Z".

The method of arriving at the classification is the same as for ABC classification described above. Only, instead of taking the annual consumption value into account, the annual stock value for each item should be taken into account. The rest of the procedure is the same.

The value of each item is expressed as a percentage of the total. By going down the list and successively cumulating the individual percentages for each item, one can determine which items make up the first 70% of inventory stock value, the next 20% and the balance 10%. The groups are called X, Y and Z respectively and the items within the group are called the X, Y or Z item.

2. PQR Classification

Besides value and criticality of the items, another commonly used method to classify items is based on the shelf life of the item. Shelf life is defined as the useful life of an item that is the time period within which the item can display the complete characteristics, for which it is meant. Items having a low shelf life and thus requiring frequent attention are classified as "P". Items having the longest shelf life and thus requiring the least attention are classified as "R". All the other items which are not P or R fall within "Q". The time period in which to define P, Q and R varies from industry to industry. This classification is more relevant in industries producing perishable goods such as confectionaries etc.

3. SDE Classification

This classification is based on the ease of obtaining an item. S stands for scarce – such items are not easily available in the market and might require source development or else it might be an item which is difficult to manufacture or there are only one or two known manufacturers who have to be given orders several months in advance and so on. All these require special efforts for procurement. D stands for

difficult to obtain and E for easy to obtain. An item, which is 'A' as well as 'S' needs completely different methods for inventory management.

NOTES

4. GOLF Classification

This classification is based on the nature of the source for an item. G stands for "Government", O for open market, L for local and F for foreign sources of supply. Items which are canalized through the State Trading Corporations, Minerals and Metals Trading Corporation, etc. come under the G category. They require special procedures for procurement and as such common procedures for inventory management may not be fully applicable for them. The transactions require more paperwork and lead times are longer. For 'O' items, there are a number of suppliers. Quality and availability is good. Most big organizations depend on the local market only for emergency supplies and low value procurement. For 'F' the source of supply is abroad; this involves considerable paperwork and lead time is high.

5. SOS Classification

This classification is based on the nature of the time of availability for an item. S stands for seasonal and OS for off-Seasonal. This is more relevant in case of items which are derived from nature – such as jute, cotton, etc. which are available more during their harvest time and less available during the monsoons when it rains. They require separate purchasing and stocking strategies. The inventory management system will have to balance out between the stocking cost and lower prices at which it will be available. 'OS' items are ordinary items which are not seasonal and can be subject to any other classification for selective control.

6. HML Classification

This classification is based on the unit price of material. H stands for high, i.e. high price per unit of the item, M stands for medium and L for low unit price of the item. This classification is particularly relevant when it comes to deciding the procedure to be followed for procurement.

5.10 METHODS OF INVENTORY ISSUE PRICING

There are four basic issues concerning inventory:

- The costs included in the acquisition cost.
- The valuation basis used for items in inventory.
- The frequency with which inventory computations occur, perpetual or periodic.
- The cost flow assumption used to trace the movement of costs into and out of inventory, which doesn't necessarily represent physical flow of inventory.

Acquisition Cost

The acquisition cost of inventory includes those costs that are necessary to bring the inventory to a condition that is sellable. For instance, the cost might include

the additional finishing touches to make the product presentable to the buyer. The extent to which these additional costs are incurred depends a great deal on the type of firm.

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A merchandising firm might buy the inventory ready for resale but will incur freight and other shipping costs to transfer the product from the manufacturer to bring the goods to the point of sale. Additional costs maybe incurred for unpacking or marking prices on the goods. In some situations the ability to track the cost of unpacking and pricing inventory may be more than the benefits of knowing the specific cost per inventory item. In this case the costs of unpacking and pricing may be assigned to the general expenses of the period rather than inventory costs. The acquisition cost of inventory is also adjusted for any purchase discounts or purchase returns. For accounting purposes the word purchase refers to goods received by the firm, not the act of ordering goods from the supplier.

A manufacturing firm also deals with the freight and shipping costs that the merchandising firm deals with as well as the other costs referred to above. However, the inventory cost reported by the manufacturing firm includes the cost of converting the raw materials to finished goods. The cost of goods sold for manufacturing firms include all the costs of a merchandising firm plus the conversion costs of goods sold during the period. The manufacturing firm indicates the extent to which its inventory costs are progressing through three inventory accounts, raw materials, work-in process, and finished goods. The last account represents those inventory items that have been converted to saleable form but remain unsold at the end of the period. The items in this account have been assigned all costs. Raw materials and work-in-process are accounts that track the costs of conversion to saleable form.

A service organization furnishes intangible services but may have inventories of items necessary to complete their services or inventories of unbilled costs or jobs in progress. Unbilled costs or jobs in progress are intangible inventories that track the progress of the service provider with regard to each client. Plumbers and carpenters may have materials inventory to indicate what materials the provider has on hand at the end of the period that has yet to be used to provide the client services. Service organizations do not have a finished goods inventory.

Valuation Basis

The general principle of inventory valuation is that inventory is reported on the balance sheet at the lower end of its cost or its market value. In most situations the inventory will be reported at its cost, however, inventory may be reduced below cost when there is evidence that the value of the items, when sold, will be less than the cost. This may occur because of obsolesence, deterioration, or significant price changes. Unfortunately the actual market value of inventory items is not necessarily easily obtainable. The Financial Accounting Standards Board (FASB) states that this estimate of market value should be the current replacement cost of the item. In other words, the amount that it would cost to currently manufacture or purchase the inventory item. The FASB has placed upper and lower bounds on the definition

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of "market". Market should not be higher than the estimated selling price less the costs associated with the sale (net realizable value) and should not be lower than the net realizable value less the normal profit margin. Thus, inventory is reported at historical cost if that is the lowest amount and at the next lowest of either current replacement cost, net realizable value (ceiling), or net realizable value minus profit margin (floor).

Perpetual versus Periodic Inventory

In each accounting period we must be able to define or determine the cost of goods sold during the period. To do that we must know the beginning inventory, the amount of purchases, and the ending inventory amounts. The cost of goods is by definition the beginning inventory plus purchases minus ending inventory. How ending inventory is determined is the choice between periodic or perpetual inventory methods.

The terms periodic and perpetual imply a time frame for determining the amount of ending inventory. In one sense the titles are descriptive. Under the periodic method we periodically determine the amount of goods remaining in inventory where periodic is defined once every accounting period and usually at the end of the accounting period. When that number is determined it is used as the beginning inventory number for the next period. Thus, inventory balances are only determined periodically. The perpetual method provides estimates of ending inventory continuously. As items leave inventory and are sold, inventory is updated to indicate the on hand unsold product. However, the perpetual inventory method is not a physical check of the inventory amount but a recording of changes in inventory when each sales transaction occurs. To actually determine the physical inventory on hand the firm must, at the end of the accounting period, take inventory just as is done using the periodic method. The difference is that the perpetual method provides an estimated ending inventory number that allows completion of the financial statements without taking a physical inventory.

Each method requires a different means of recording the flow of goods in and out of the firm. Under the periodic method an account called "Purchases" is used to record the additional inventory items purchased for sale during the period. In the perpetual system purchases of inventory during the period are recorded directly to the inventory account. For example,

Periodic	Recording Inventory	Purchase for Cash
Purchases	$1,000 Cash	$1,000
Perpetual	Recording Inventory	Purchase for Cash
Inventory	$1,000 Cash	$1,000

At the end of the accounting period the periodic method requires that the purchases account and the inventory account are closed to costs of sold and the ending inventory number from the physical inventory count be entered in the inventory account. Assume that the inventory account from the example above began at $500 and the ending inventory was found to be $750.

Cost of Goods Sold. $500

Inventory: $500

Cost of Goods Sold: $1,000, Purchases: $1,000

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Inventory: $750 Cost of Goods Sold: $750

At this point you should be able to determine that cost of goods sold for this example must be $750 ($500 + $1,000 – $750 = $750).

Under the perpetual system cost of goods sold and inventory are adjusted at each sale.

Perpetual record sale of goods on account for $1,000 cost = $500

Accounts Receivable	$1,000 Sales	$1,000
Cost of goods sold	$500 Inventory	$500

The accounts reflect the transactions for the period and cost of goods sold can be used to complete the income statement for the period.

Cost Flow Assumptions

There are times when a firm can match the inventory item sold with a specific purchase (e.g., automobiles). In these cases the actual cost of the inventory item can be identified and the cost of goods sold accurately reflects the cost of sales. In other situations the physical flow of inventory makes specific identification impossible and the firm must rely on estimates of costs of goods sold that reflect assumptions made about cost flow, not physical flow of goods. Even in situations where specific identification is possible the firm may choose to use a cost flow assumption to achieve some tax or financial presentation objective.

When making the decision about which cost flow assumption to choose we are implicitly deciding which number, inventory on the balance sheet, or cost of goods sold on the income statement, will reflect current costs of inventory or making a decision to present only average inventory cost values in both instances.

The cost flow assumption that generates current inventory costs on the balance sheet and outdated inventory costs on the income statement is FIFO (first in, first out). Adopting FIFO assumes that the first inventory purchased is also the first inventory that leaves the store when units are sold. In practice it is very likely that FIFO is more representative of actual physical inventory flow than the other cost flow assumptions. Thus, regardless of whether prices are rising or falling the balance sheet inventory number reflects the inventory purchased or produced last. The income statement cost of goods sold reflects the inventory purchased or produced first. The cost flow assumption that generates current costs for cost of goods sold and outdated costs for inventory on the balance sheet is LIFO (last in, first out). Thus, regardless of whether prices are rising or falling the balance sheet inventory number will reflect the items purchased or produced first and the cost of goods sold number will reflect those items purchased or produced last. Finally, the cost flow assumption that presents average

values for both the balance sheet and income statement inventory cost numbers is weighted average. The weighted average assumption weights inventory costs by the number of units acquired at a specific cost. The total inventory cost after weighting is divided by the total units in inventory and the average unit cost is assigned to both units that make up cost of goods sold and units that make up ending inventory.

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Below is a sequence of inventory purchases and sales. Following the sequence is the determination of cost of goods sold under each of the assumptions.

Purchase Inventory 300 units at $6

Purchase Inventory 400 units at $7

Sell 300 units at $12

Purchase Inventory 200 units at $8

Sell 400 units at $12

Purchase Inventory 200 units at $5

FIFO

Total sales — 700 units. Assumption — first units purchased are sold

Cost of Goods Sold = (300 × $6 + 400 × $7) = $4,600

LIFO

Total sales — 700 units. Assumption — last units purchased are sold

Cost of goods sold = (200 × $5 +200 × $8 + 300 × $7) = $4,700

Weighted Average

Total Sales—700 units. Assume a weighted average cost per unit

Average weighted cost per unit = $7,200/1100 = $6.55

Cost of goods sold = $6.55 × 700 = $4,585

Choosing a cost flow assumption affects the firm's reported net income for the period. FIFO will generally produce higher income numbers but higher tax bills, LIFO produces lower income numbers and a lower tax bill. The weighted average approach will generally produce numbers between LIFO and FIFO. The choice is LIFO for tax purposes and requires firms to use LIFO for financial reporting purposes.

5.11 COST AND PROFIT IMPLICATION

A truly effective inventory management system will minimize the complexities involved in planning, executing and controlling a supply chain network which is critical to business success. The opportunities available by improving a company's inventory management can significantly improve bottom line business performance.

From a financial perspective, inventory management is no small matter. Often at times, inventory is the largest asset item on a manufacturer's or distributor's balance

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sheet. As a result, there is a lot of management emphasis on keeping inventories down so they do not consume too much cash. The objectives of inventory reduction and minimization are more easily accomplished with modern inventory management processes that are working effectively.

Every business desires to maximize its profit. Profitability is the foremost goal of every company. We are going to look into how the Inventory control relates to this goal, to meet the high customer service level while contributing positively to the company's bottom line. There are three types of inventory classified according to the profit making:

(a) **The Good:** The inventory that provides a positive return on our investment. We make money from the sale of this inventory.

(b) **The Bad:** The inventory that doesn't provide return on investment, but merely contributes to other profitable sales. For example, spare parts for automotive.

(c) **The Ugly:** The inventory that doesn't provide a return on investment, and doesn't contribute to profitable sales. We must liquidate this type of inventory immediately.

When we ask any salesperson about the profit of their company, they will mention about the gross margin of the company. Gross margin is defined as below:

$$\text{Gross Margin (GP)} = \frac{\text{Annual Sales Dollars} - \text{Cost of Goods Sold}}{\text{Annual Sales Dollars (Revenue)}}$$

The higher the gross margin, the better the profit. Under most circumstances, the G.P. is approximately 20% for the distributor or wholesaler. But does the company actually make money with that 20% of margin? It is uncertain as the actual net profit depends on the average value of inventory we need to maintain to generate the sales. The average inventory investment will depend on cost of the products, variation in customer demand and quantities that must be purchased in order to sell the products at a competitive price. As mentioned earlier, the carrying cost of a product is about 25% – 30% per year of the average inventory value. A product with a gross margin of 25% should contribute more than a product with a gross margin of 20%.

5.12 INVENTORY LEDGER

The inventory ledger in the accounting system is updated each time a transaction is processed on a stock item. An inventory ledger is a document or collection of paperwork used by a company to track products based on quantity and value. This often allows a business to evaluate how materials and goods are coming into the company, how well they may be moving out due to sales, and to gauge any losses that may occur. One common type of inventory ledger is perpetual, while some companies may prefer to use a periodic ledger. These two common types of inventory

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ledger vary based on the frequency of updates performed on each. When a stock item is received the inventory account balance is increased with a debit entry whilst the inventory suspense account is reduced with a credit entry. When a stock item is invoiced the inventory account balance is decreased with a credit entry whilst the cost of sales account balance is increased with a debit balance.

There are a number of different forms that an inventory ledger can take, though traditionally it is a book with numerous pages. Each of these pages has a layout that usually includes multiple columns that can be used to note different information, such as quantity, value, and descriptions of items. A business usually has an inventory ledger with separate pages for certain types of items, such as individual accounts. Modern technology has made it easier for companies to keep such ledgers, and many businesses use computer software to maintain digital records of inventory and goods for production or sale.

One of the most common types of inventory ledger is one that is referred to as "perpetual," which is updated on an ongoing basis. Companies that employ this type of ledger typically have an automated system that tracks the transfer of products due to sales or incoming orders. This means that as goods are sold, the inventory ledger is immediately updated to reflect this transfer, and as new materials come into the company they are added to the ledger. While such methods are not practical for every business, they can allow a company to track its inventory quickly and adjust orders for materials as needed.

The other common form of inventory ledger is called "periodic" and is updated on a regular basis, but not immediately upon changes to inventory. This usually requires a physical count of products and goods at a company, which is then used to adjust internal numbers regarding what materials are on hand. Such counts are typically performed on a set schedule, which can range from annual full inventory counting to weekly evaluations for high-risk items. A ledger of this type, used for periodic counts, is usually updated less frequently than a perpetual one, but the changes can be more dramatic depending on how products sell or come in over time.

The stock ledger template may contain:

- Company name
- Date
- Received date/Issue date
- Quantity order
- Quantity received
- Quantity issued
- Batch number
- Balance
- Authorization

Consider the attached sample template for your convenience.

NOTES

Serial

Stock Ledger

Name of Facility ____________ Facility Code ____________

Item Description ____________ Item Code ____________

Unit of Issue ____________

Date	Received from/ Issued to:	Delivery note/ Issue Y. No.	Batch No.	Expiry Date	Quantity Received	Quantity Issued	Signature

Fig. 5.8: Goods receipt processing with inbounds delivery/without inbound delivery

Goods Receipt Processing with Inbounds Delivery

An inbound delivery is a document containing all the data required for creating and completing the inbound delivery process. This process starts on receipt of the material at the receiving dock and ends with the put away of the material in a storage bin in the warehouse. This section will review goods receipts with inbound deliveries, so we will start with an overview of the process.

Inbound Delivery Overview

An inbound delivery can be created with reference to several processes:

- Purchase order
- Stock transport order
- Customer return

There are many reasons to create inbound deliveries. The most useful one is that you can perform some processes in the SAP system before the material arrives and a goods receipt is posted. The vendor can send information about the inbound delivery, which informs the warehouse of the items being sent, the information they contain, and the precise date and time of delivery.

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The goods receipt process for inbound deliveries is an essential part of the supply chain. This process includes the steps after creation of the purchase order: notification, the inbound delivery, subsequent put away of goods, and the goods-receipt posting of the ordered goods.

The significant advantage of depicting the goods receipt process through the inbound delivery function is that you can execute many processes in advance, even before the actual goods receipt posting takes place. You have all the necessary information beforehand because the supplier notifies you of the inbound delivery ahead of time. The inbound delivery describes exactly which materials or pallets can be received on what date and at what time.

The following functions are available with the goods receipt process for inbound deliveries:

- Transfer order for inbound delivery
- Like the outbound delivery, the inbound delivery is a request for putaway that is sent to the warehouse. You can create a transfer order for putaway from an inbound delivery.
- Batch information
- The batch split that is already possible for outbound deliveries is also available for inbound deliveries, since batches are often first identified in the inbound delivery.
- Inventory management of packaging materials
- Goods receipt for inbound deliveries
- Define order confirmation for inbound delivery
- You can use this key to configure your settings such that planned inbound deliveries are automatically created through a collective processing run.
- Inbound delivery monitor
- Determination of goods receiving point
- Incompletion log
- Change documents
- Document flow for inbound delivery

Process Flow

The inbound delivery process starts when the goods are staged at the vendor's shipping point, and it ends when the ship-to party makes an acquisition posting for the goods.

- Create a purchase order or a scheduling agreement.
- The system can determine a goods receiving point.
- The system creates an inbound delivery automatically if you receive a shipping notification via Electronic Data Interchange (EDI).

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You can also create an inbound delivery manually if you do not use EDI to communicate with your supplier.

- Repack the goods, if necessary.
- Put the materials away by creating a transfer order in the warehouse.
- Post the goods receipt.

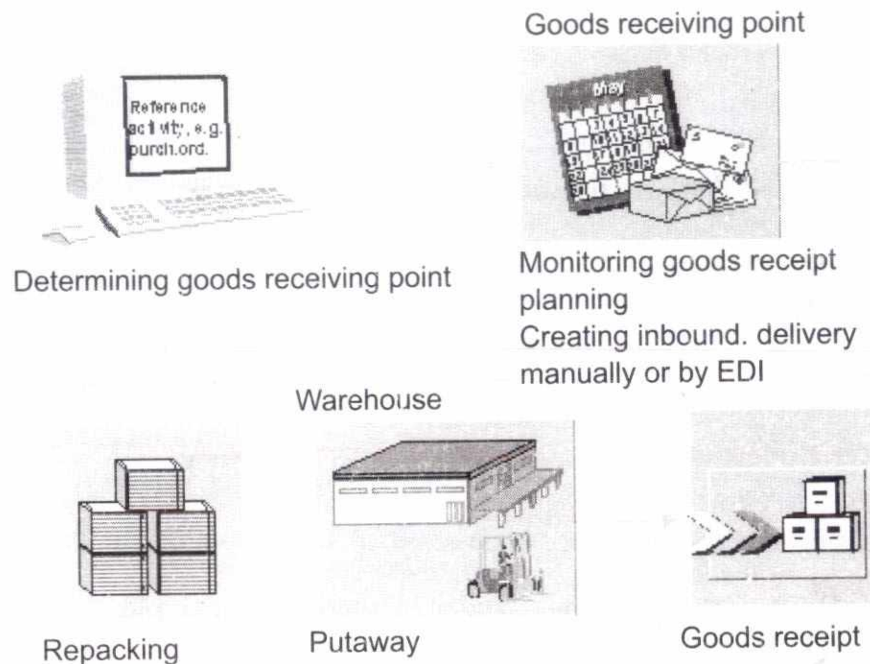


Fig. 5.9: The goods receipt process

Goods Receipt Processing without Inbounds Delivery

A goods receipt without an inbound delivery can occur when material arrives at the receiving dock without reference to an inbound delivery. The goods receipt occurs in Inventory Management (IM) , and a transfer requirement is created for the movement of the material into the warehouse.

Goods Receipt in IM

Goods receipts relevant to a warehouse management system can be produced by the arrival of material at the plant from a purchase order with a vendor. A goods receipt can be defined as a company's formal acceptance that materials were received from a vendor against a purchase order. Once the material is received and the transaction completed, the value of the material is posted to the general ledger.

Reviewing the Material Documents

After all the relevant details such as storage location, batch number, and so on, have been added to the goods receipt transaction, the goods receipt can be posted. If the

goods receipt does not return any error messages, the transaction will post and display the number of the material document for the movement of the material.

5.13 GOODS ISSUE WITH OUTBOUND DELIVERY/ INTERNAL CONSUMPTION

Goods issue for an outbound delivery in the Warehouse Management system (WMS) includes picking and goods issue posting for a material to be delivered, based on the outbound delivery. If you map the goods issue process via an outbound delivery, you can execute the processes related to the goods issue within the warehouse (picking, stock removal) before you trigger the actual goods issue posting.

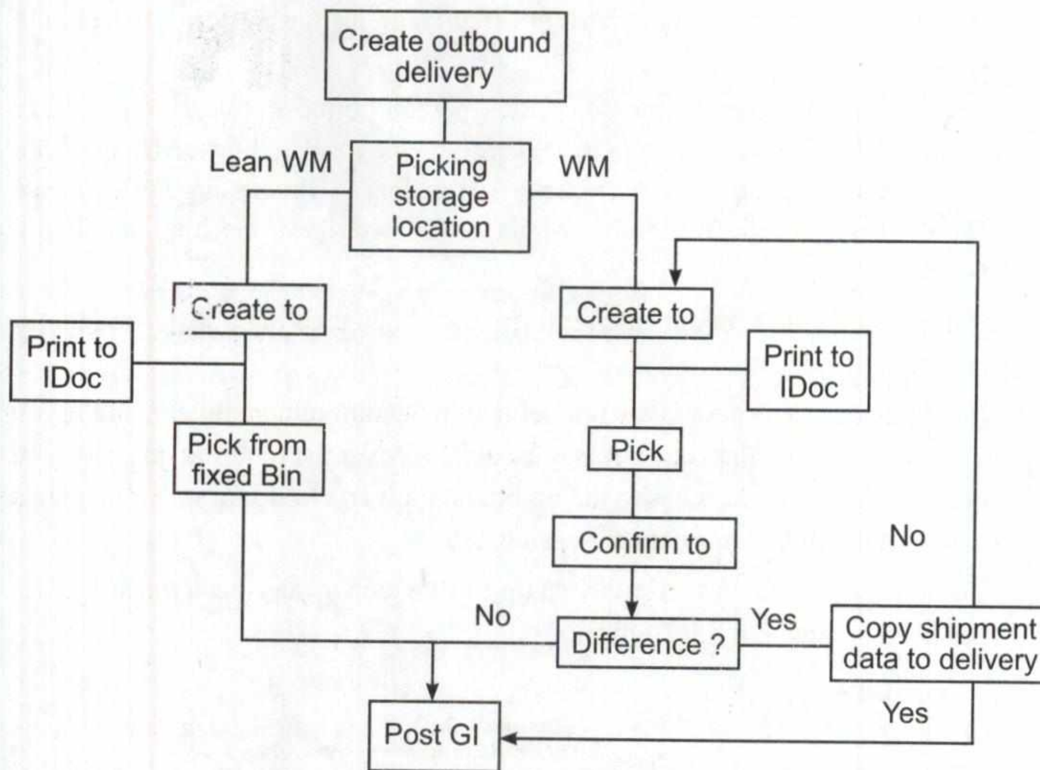


Fig. 5.10: Goods issue for an outbound delivery using wms or lean wm

Prerequisites

You have activated the interface between Shipping and the WMS in the Customizing for Warehouse Management under Interfaces Shipping.

You have created outbound deliveries or scheduling agreements in SAP Shipping (LE-SHP) based on sales orders. The outbound deliveries serve as reference documents for the picking processes to be performed in the WMS.

The material to be picked is stored in a WM-managed storage location.

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You have defined a picking strategy in the Customizing for Warehouse Management under Strategies → Picking Strategies.

Process Flow

1. You create the outbound delivery for a sales order or for another preceding document.

   The system recognizes at outbound delivery item level which items are relevant for stock removal with the WMS. It sets the WM activity status in the outbound delivery to A (relevant to Warehouse Management).
2. You create the transfer order to for the outbound delivery for picking from your warehouse.

   You can create the transfer orders directly or let the system create them automatically.

   You can create several transfer orders per outbound delivery if you have activated the transfer order split in the Customizing for Warehouse Management. For more information, see Activities → Transfers → Processing Performance Data/TO Split in the Warehouse Management section of the Implementation Guide.
3. You can take into account batch information when creating transfer orders for picking.
4. If the batches to be picked are not defined in the outbound delivery, and if you want to pick more than one batch to be able to cover the required quantity, you must confirm these batches to the outbound delivery. In doing so, you create a new outbound delivery item for each batch.
5. The system sets the WM Activity status to B, which means that a transfer order has been created but not confirmed.

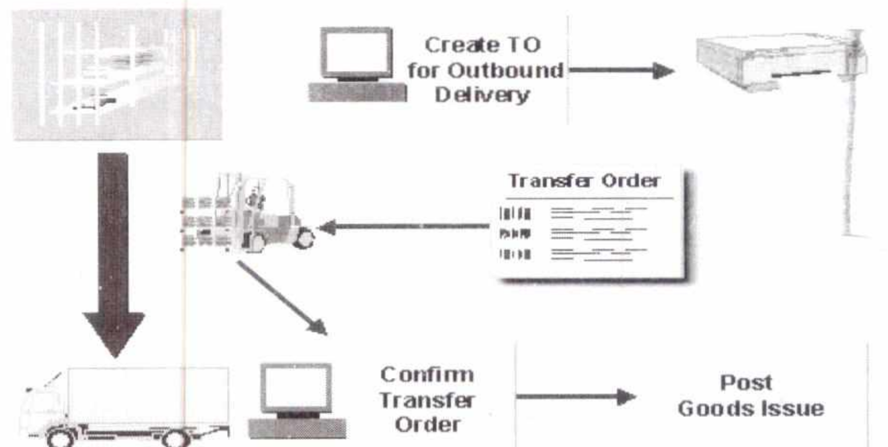


Fig. 5.11: Create transfer order for outbond delivery

6. A print out of the TO serves as a picking document when removing goods from the source storage bin that has been determined, to the goods issue interim storage area.
7. By confirming the transfer order, you confirm that the goods have been brought to the goods issue interim storage area.
8. In doing so, you record any stock differences between the required quantity and the picked quantity.
9. Post the goods issue for the outbound delivery.

Procedure of Goods Issue for Outbound Delivery

You can stay informed about the progress of the stock removal throughout the entire goods issue process via the outbound delivery, since the system updates the WM activity status every time a step is completed in the transfer order processing.

5.14 STOCK TRANSFER SCENARIO

Inventory operations have two key elements namely inventory system and physical operations. Today inventory systems have replaced the book keeping and financial accounting that was being practiced earlier. Current inventory systems not only do the book keeping but are linked to upstream as well as down-stream activities including procurement, sales processing, and financial accounting.

In terms of measuring a sales performance in relation to Inventory, we often use the term inventory turnover. Inventory turnover simply refers to the number of times the inventory is sold or used in a period of one year. Inventory turnover is also termed as stock turn, or stock turnover.

Inventory turnover is calculated by taking the total cost of goods sold, divided by average inventory. Adding together beginning inventory and ending inventory and dividing the figure by 2 in turn calculates the average Inventory.

The inventory turnover as a measure of health of sales and business is used extensively in retail, textile as well as FMCG segments. A higher inventory turnover does indicate a healthy trend of increased sales and indicates the need to maintain adequate inventory levels to avoid stock-outs. In-adequate stocks can result in loss of business opportunities and is something that the management needs to keep watching closely. On the other hand, a lower inventory turnover shows that either the sales of the said inventory is slowing down or that the unused inventory is building up clogging the system somewhere. A slow inventory turn can help the inventory manager focus on finding non-moving, obsolete and slow moving inventory items and thereby steps can be taken to deal with them appropriately.

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Check Your Progress

State Whether the Following Statements are True or False

5. The holding cost of inventory includes those costs that are necessary to bring the inventory to a condition that is sellable.
6. An inventory ledger is a document or collection of paperwork used by a company to track products based on quantity and value.
7. The outbound delivery process starts when the goods are staged at the vendor's shipping point, and it ends when the ship-to party makes an acquisition posting for the goods.
8. Goods issue for an outbound delivery in the Warehouse Management System (WMS) includes picking and goods issue posting for a material to be delivered, based on the outbound delivery

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Inventory turnover also reflects the holding cost that is incurred in managing inventory. Increased inventory turns reduce the holding costs. The costs especially fixed costs like rent and cost of operations get distributed over higher inventory throughput and thereby the cost of inventory transactions reduces.

Inventory turnover is also indicative of the health of inventory operations. When the inventory turnover is higher, the inventory operations efficiency will also be high to meet with the increased operational requirements thereby good house keeping and increased responsiveness to market requirements.

Inventory turn in some cases or some systems is also calculated based on the numbers sold rather than the average value of inventory. In such a system the inventory turn is calculated by dividing the number of units sold divided by the average number of units inventory held in a given period of time.

Over a number of years, each industry has developed methods to check inventory turnover and industry standards have been standardized. So whenever a new business venture is set up, they are able to have the industry standard as benchmark to be achieved and use it as a guide to streamline operations.

5.15 SUMMARY

- Inventory management involves the control of current assets being procured or produced in the normal course of the company's operations i.e. or "how many" parts, pieces, components, raw material and finished goods the firm should hold and when should it replenish the stock.
- Inventory is a stock of materials used to satisfy customer demand or support the production of goods or services.
- To maintain independence of operations, a supply of materials at a work center allows that center flexibility in operations.
- The heart of inventory decisions lies in the identification of inventory costs and optimising the costs relative to the operations of the organisation.
- The economic order quantity (EOQ) is the replenishment order quantity that minimises the combined cost of inventory maintenance and ordering. Identification of such a quantity assumes that demand and costs are relatively stable throughout the year.
- When the stock of an item is depleted, an order for that item must either wait until the stock is replenished or be cancelled.
- ABC classification, or the alphabetical approach, is based on the annual consumption value.
- A truly effective inventory management system will minimize the complexities involved in planning, executing and controlling a supply chain network which is critical to business success.

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- The inventory ledger in the accounting system is updated each time a transaction is processed on a stock item.
- Goods issue for an outbound delivery in the Warehouse Management System (WMS) includes picking and goods issue posting for a material to be delivered, based on the outbound delivery.
- Inventory turnover simply refers to the number of times the inventory is sold or used in a period of one year. Inventory turnover is also termed as stock turn, or stock turnover.

5.16 KEY TERMS

- **Inventory management:** Inventory management involves the control of current assets being procured or produced in the normal course of the company's operations i.e. or "how many" parts, pieces, components, raw material and finished goods the firm should hold and when should it replenish the stock.
- **Economic Order Quantity (EOQ):** The economic order quantity (EOQ) is the replenishment order quantity that minimises the combined cost of inventory maintenance and ordering.
- **ABC classification:** ABC classification, or the alphabetical approach, is based on the annual consumption value.
- **Inventory ledger:** The inventory ledger in the accounting system is updated each time a transaction is processed on a stock item.
- **Inventory turnover:** Inventory turnover simply refers to the number of times the inventory is sold or used in a period of one year. Inventory turnover is also termed as stock turn, or stock turnover.

5.17 ANSWERS TO 'CHECK YOUR PROGRESS'

1. Inventory Management involves the control of current assets being procured or produced in the normal course of the company's operations i.e. "how many" parts, pieces, components, raw materials and finished goods the firm should hold and when should it replenish the stock.
2. This constitutes partly-finished parts, components, sub-assemblies or modules that have been started into the production process but not yet finished.
3. It is the stock that is always kept in store to protect against uncertainties. It is a buffer.
4. Stock kept at hand to meet seasonal fluctuations in demand or to meet the shortfall caused by erratic production. Also called build stock or seasonal stock.

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5. False
6. True
7. False
8. True

5.18 QUESTIONS AND EXERCISES

Short Answer Questions

1. Define inventory management. Explain its significance.
2. What are the key functions of inventory management?
3. Define EOQ and ABC Analysis.
4. Explain the meaning of holding cost.
5. Write a brief note on stock transfer scenario.

Long Answer Questions

1. Define inventory management. Explain the key needs and functions of inventory management?
2. Examine the stock levels under the conditions of certainty, risk and uncertainty.
3. Illustrate the meaning and concept of EOQ.
4. Analyze the key techniques of inventory classification?
5. Discuss the methods of inventory issue pricing?
6. Write a note on the following:
   (a) Goods receipt processing with and without inbound delivery
   (b) Goods issue with outbound delivery

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UNIT 6 IT FOR WAREHOUSE MANAGEMENT (WM)

Structure

6.0 INTRODUCTION

A distributor's warehouse should also be supported by an efficient yard management system to schedule trailer movement, remove bottlenecks, and provide upstream and downstream visibility. Efficient yard management can improve a distributor's customer satisfaction metrics by facilitating on time delivery or proactive delay notifications. The advent of new technologies like RFID has the potential to redefine the way distributors manage their high volume warehouses. However, the unprecedented wave of consolidation in the distribution industry, changing business models, proliferation of legacy systems are preventing distributors from realizing proper return on their technology investments in the warehouse management space.

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6.1 UNIT OBJECTIVES

After going through this unit, you will be able to:

- Describe warehouse documentation
- State the information flow in a warehouse
- Discuss the key concepts like ERP, WMS, Bar Codes and RFID
- Define warehouse structure and its key elements
- Know how to create transfer requirement automatically/manually.

6.2 WAREHOUSE DOCUMENTATION

Documentation becomes important not only for the physical logistics operations involving multiple agencies engaged in the entire chain, the financial, trading and accounting processes of the both buyer and seller organisations and partner banks involved also depend upon the entire set of documentation pertaining to each transaction to be able to recognize the sale, recognize value of consignment and effect necessary payment. Accounting practices of the organisations require detailed documentation as per book keeping practices and norms. Finally goods and services are recognized and identified at every stage only with the set of authenticated documentation showing ownership based on which the customs allow them to be exported or imported into or out of the country. There are many more aspects like terms of carriage by the carrier coupled with insurance liabilities and coverage which call for set of documentation covering specific aspects of each transaction.

Therefore, the entire supply chain transaction involves a set of standardized documentation from buyer and seller, from 3PL carriers and documentation as required by customs at exporting country and importing country coupled with trading or bank requirements documents. The entire set of documents and the terms of trade have been developed and standardized across all countries to facilitate international trade.

INCO (Inco terms are worldwide accepted commercial terms that define the respective roles of the buyer and of the seller regarding the arrangement of the transportation and other responsibilities.) terms and Electronic Data Interchange (EDI) approved / enabled standardized documentation has made Export and Imports smoother and hassle free, thus cutting down on bottlenecks and delays arising out of documentation requirements.

Today software applications have built in standardized documentation templates and modules in their offerings which reduce the amount of time and effort involved in preparing documentation. ERP modules contain the documentation formats as an integral part of its internal processes. 3PL logistics providers work with various software applications which have shipping documentation built into its operational processes and offer track and trace with documentation visibility to customers on the web. Filing documents with customs has been EDI-enabled. Electronic documentation

has become a part of operations amongst all agencies. However, at customs and banking counters, original documents are required to be produced as negotiating and legal valid documents for shipments to be cleared through.

6.3 INFORMATION FLOWS IN THE WAREHOUSE

The following illustration outlines typical warehouse flows.

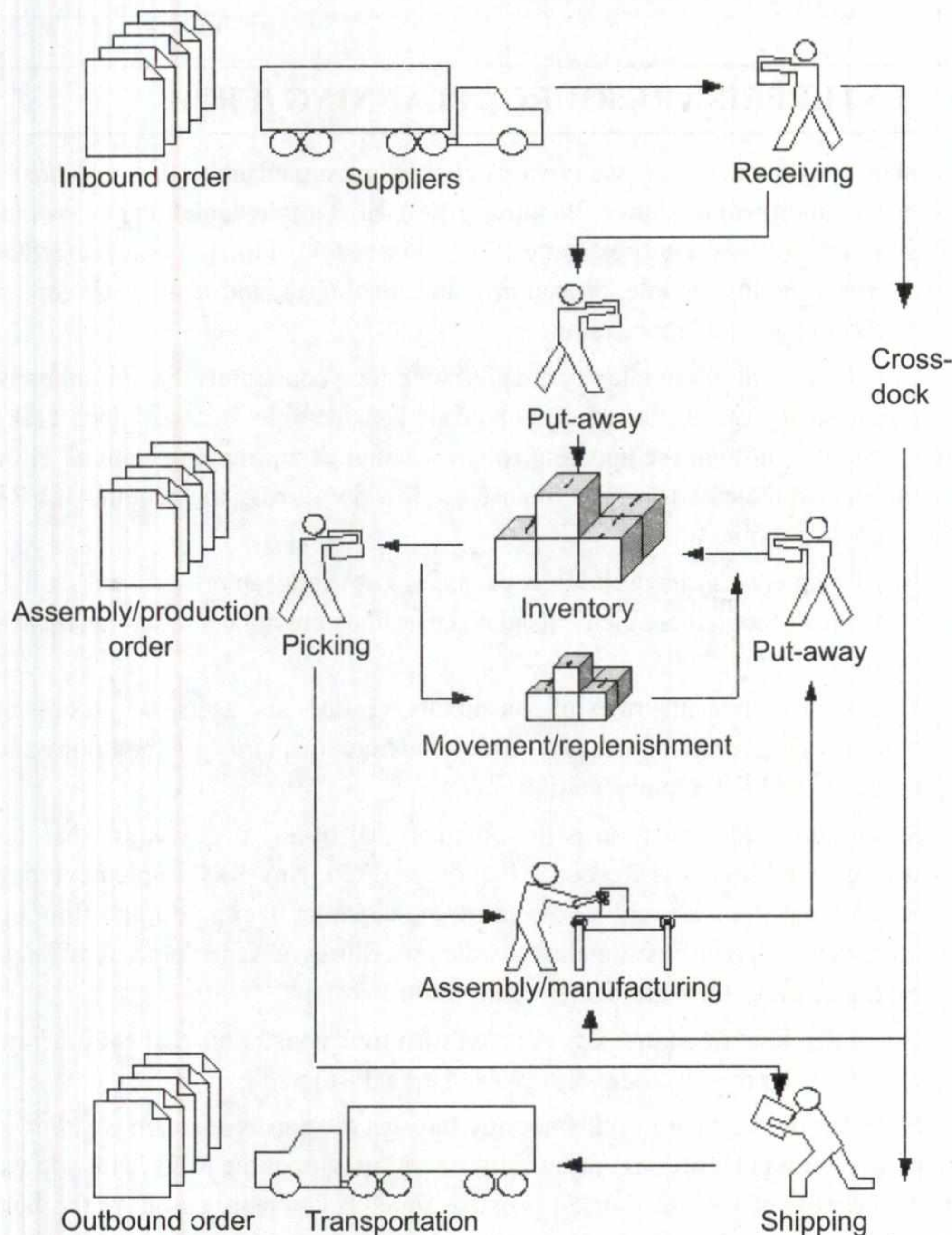


Fig. 6.1: Warehouse flows

Refer to the following terms for item flow in the warehouse:

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Term	Description
Inbound flow	Items moving into the warehouse location, such as purchases and inbound transfers.
Internal flow	Items moving inside the warehouse location, such as production components and output.
Outbound flow	Items moving out of the warehouse location, such as sales and outbound transfers.

6.4 ENTERPRISE RESOURCE PLANNING (ERP)

Successful implementation is the obvious goal of any organisation that has chosen to go in for Enterprise Resource Planning (ERP). ERP implementation is a special event since it involves the entire organisation over a period of time. It brings together different functionality, people, procedures, and ideologies, and leads to sweeping changes throughout the organisation.

Given this kind of complexity coupled with time constraints that are inherent in almost all such projects, the risks involved are considerable. But what does it take to sail smoothly through the apparent rough weather of an implementation? How does one sustain the enthusiasm of the users? How do we reap the benefits of ERP in the shortest possible time?

Any company can have the best package, knowledgeable users, substantial resources, but although these elements play a part, they are not enough to guarantee the success of ERP.

This unit discusses the roles of consultants, vendors and users, the process of customisation, the precautions, the key issues, the implementation methodology and the guidelines for ERP implementation.

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ERP Project Life Cycle

ERP project life cycle can be classified into the following three stages:

Stage 1: Pre-implementation Stage

This phase is the one in which companies must question the need for a new ERP system. The development of the business case analysis is carried out to establish the need for ERP system. Various methodologies are used to assess the critical processes and practices of that company and also attempts are made to forecast the impact it can have both financially and business-wise. This phase consists of selection of the product that best fits the requirements of the company, thus, minimising the need for customisation. Factors such as price, training and maintenance services are analysed and the contractual agreement is defined. In this phase, it is also important to make an analysis of the return on investment of the proposed solution.

Business Case Analysis

Most of the companies tend to take the high risk decision of carrying on with the implementation of ERP because of the following reasons:

- It is the main thing although it may not at all be suitable for them. In some cases, it has even led companies to bankruptcy. Yet people seem to be blindly choosing the implementation of ERP.
- It is supposed to cut costs and time and streamline the process of their organisation.
- Mindset to change to invest heavily in terms of money, energy and time. Generally, it is seen that interest and enthusiasm remains only in the initial phases. Over a period of time, the interest starts declining due to lack of commitment.

Business case analysis basically focuses on all the related issues involved and the various methodologies that are followed in carrying out this phase successfully, so that one can take the decision with regard to the implementation of ERP with strong evidences, which can be quantified and measured during each phase of the life cycle of ERP.

The following points are studied in business case analysis:

Need to adopt Global Best Business Practices

Best practice is the process of finding and using ideas and strategies from other companies and industries to improve performance in any given area. Business has used best practice benchmarking over the decades and realised billions in saving and revenues in all areas of business operations and sales. Best practices are studied in two ways:

1. **'As is' best practice:** This addresses or includes the present practices followed by the specific company which is planning to implement the changes required

to keep itself in the league of other top companies in the industry. This is done in all functional areas like HR, Operations, Finance, Maintenance, etc.

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2. **'To be' best practice:** They are generally the best practices which exist in the industry and have been refined over a period of time. Companies should aim at adopting their industry specific best practices for their future benefit. Some of the best practices are: preventive maintenance, activity-based costing, Kanban, etc.

   Some of the best practices that can be adopted are as follows:

   - *Information liquidity:* Much like cash liquidity, the liquidity of information is a measure of business success. In a successful company, data flows smoothly and information is transformed into economic value.
   - *Availability:* As most of the companies become more and more dependent on IT, it is very important to ensure the maximum availability of the services. This does not mean that all IT systems have to be absolutely flawless and foolproof but good thought has to be given to what could be the consequences for the company if all or part of the IT services are temporarily unavailable and what can be done to minimize these consequences.
   - *Agility:* Market changes constantly and so does legislation and technology. It is said that the product lifecycle and their time to reach the market are getting shorter and shorter as a consequence; IT systems have to be built for maximum agility, cross compatibility, reuse and lightweight functionality are the ideas to be considered.

Need to Adopt Global Best Processes

'As is' best processes address or include the following:

- Design of products and services
- Marketing and selling
- Production and delivery of products
- Conversion of resources or inputs into products
- Warehousing
- Managing inventory
- Product quality assurance
- Maintenance process
- Servicing of customers
- After sales service
- Customer relationship management
- Managing human resources

Companies need to define their own employees in order to improve their way of operation and efficiency. By adopting these methods the company will be able

to save a lot of operating costs and expenditures and also eliminate unnecessary bottlenecks in the processes.

Need to Adopt Global IT Infrastructure

'As is' IT infrastructure study is done in order to know the following points:

- What is the application that is running in that company-in-house or customized/ standardized one
- Are all modules integrated or run on different packages and platforms?
- What is the connectivity scenario whether using web-based interface or stand alone ones?
- Is a centralised database or a different one being used?
- What is the present platform in terms of front end and back end?
- To what extent does it serve the purpose?
- Is there any duplication of effort in order to capture vital data that impacts employee efficiency?

Stage 2: Implementation Stage

It mainly deals with change management, project management, IT infrastructure management and the implementation approach due to the implementation of ERP. A lot of changes occur in the company structure and the existing business process to cope up with this change. Training programmes are conducted, visits to ERP sites are arranged and workshops are held to educate employees about the change process and also about the ERP package and its effective utilisation. Project management schedules are made in which the project orientation, time, cost and quality are considered. After assessing the company's readiness, decision for the implementation approach is taken, as to whether it should be a phased one or a big bang approach.

Stage 3: Post Implementation Stage

The ERP life cycle does not end when the project goes live. After that the post impact analysis of the project is done, generally after 1-2 years of implementation. Analysis is carried out regarding the optimum utilisation of resources in the project. The impact such as financial, operational, organisational, etc. which ERP implementation had on the total business is calculated and the profitability is measured thereof. It is studied whether further improvements can be done on the project for future upgradation and benefits.

6.5 WAREHOUSE MANAGEMENT SYSTEM (WMS)

A Warehouse Management System is the combination of hardware computing devices, mobile and desktop software and peripheral interfaces for utilising in

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organising all aspects of a warehouse and stockyard. At its center, a warehouse management system is capable to place inventory, give configurable management for exact warehouse tasks and organise inventory as it enters and exits the warehouse. Of course, the difficulty of a Warehouse Management System is directly related to the difficulty of the warehouse that it will serve.

For small warehouse operations, slightly more than an inventory locator, inventory counting module, and a basic shipping-receiving package may be required. In some situations, a Warehouse Management System may not be needed at all. Because the WMS usually needs the expertise of Information Technology (IT) professionals, it only makes sense to implement a Warehouse Management System if the cost lessening benefits of owning such a system can make up for the costs associated with the IT expend regardless of whether those resources are outsourced or staffed.

Warehouse management systems implementing automatic data identification technology, such as mobile computers, barcode scanners and RFID, can professionally supervise product flow all through the warehouse. Once data has been composed for various warehouse responsibilities or inventory managed processes, the data is warehoused in a relational database system allowing managers visibility into the real-time rank of goods in the warehouse.

A Warehouse Management System, or WMS, is a key part of the supply chain and primarily aims to control the movement and storage of materials within a warehouse and process the associated transactions, including shipping, receiving, put-away and picking. The systems also direct and optimize stock put-away based on real-time information about the status of bin utilisation.

Warehouse management systems often utilize Auto ID Data Capture (AIDC) technology, such as barcode scanners, mobile computers, wireless LANs and potentially Radio-Frequency Identification (RFID) to efficiently monitor the flow of products. Once data has been collected, there is either a batch synchronisation with, or a real-time wireless transmission to a central database. The database can then provide useful reports about the status of goods in the warehouse.

The objective of a Warehouse Management System is to provide a set of computerised procedures to handle the receipt of stock and returns into a warehouse facility, model and manage the logical representation of the physical storage facilities (e.g. racking, etc.), manage the stock within the facility and enable a seamless link to order processing and logistics management in order to pick, pack and ship product out of the facility.

Warehouse Management Systems can be standalone systems or modules of an ERP system or supply chain execution suite.

The primary purpose of a WMS is to control the movement and storage of materials within a warehouse – you might even describe it as the legs at the end-of-the-line which automates the store, traffic and shipping management.

In its simplest form, the WMS can data track products during the production process and act as an interpreter and message buffer between existing ERP and WMS systems. Warehouse management is not just managing within the boundaries of a warehouse. Today, it is much wider and goes beyond the physical boundaries. Inventory management, inventory planning, cost management, IT applications and communication technology to be used are all related to warehouse management. The container storage, loading and unloading are also covered by warehouse management today. Warehouse management today is a part of Suppiy Chain Management (SCM) and demand management. Even production management is to a great extent dependent on warehouse management. Efficient warehouse management gives a cutting edge to a retail chain distribution company. Warehouse management does not just start with receipt of material but it actually starts with actual initial planning when container design is made for a product. Warehouse design and process design within the warehouse (e.g. Wave Picking) is also part of warehouse management. Warehouse management is part of logistics and SCM.

Warehouse management monitors the progress of products through the warehouse.

It involves the physical warehouse infrastructure, tracking systems, and communication between product stations.

Warehouse management deals with receipt, storage and movement of goods, normally finished goods, to intermediate storage locations or to the final customer. In the multi-echelon model for distribution, there are levels of warehouses, starting with the central warehouse(s), regional warehouses serviced by the central warehouses and retail warehouses serviced by the regional warehouses and so on. The objective of warehouse management is to help in optimal cost of timely order fulfilment by managing the resources economically. Warehouse management is defined as, "Management of storage of products and services rendered on the products within the four walls of a warehouse."

The Roles of Warehouse Management System are:

- WMS will reduce inventory
- WMS will reduce labour costs
- WMS will increase storage capacity
- WMS will increase customer service
- WMS will increase inventory accuracy

6.6 BAR CODE

Bar codes are used to identify the contents of package and provide information on the product as well as the package. Bar coding and electronic scanning are hardware-cum-software identification technologies which facilitate logistics information collection and exchange. Bar coding refers to the placement of computer readable

codes on items, cartons, containers, trucks and even railway wagons. The scanning process is the "eye" of a bar code system. A scanner optically collects bar code data and converts them to usable information.

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These technologies are *auto identification (ID) systems*. The *Universal Product Code* (UPC) is present on many consumer products and is used extensively in the consumer goods industry for retail checkouts. UPC is a ten-digit number which assigns a unique five-digit number identification to each manufacturer and product. The lines and spaces of a bar code are of varying thicknesses and printed in different combinations. When there is accurate printing and adequate contrast between the bars and spaces, the codes can be scanned and converted into useful information. Standardized bar codes reduce errors when receiving, handling, or shipping product. Figure 6.2 is a bar code of a series of numbers encoded in UPC.

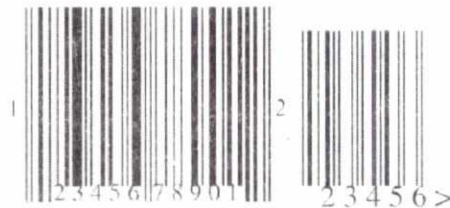


Fig. 6.2: A UPC bar code

UPC bar codes have been successfully accepted by retailers who are concerned with individual items, shippers and carriers are interested in the contents of pallets or containers. In addition to product or package identification, it also enhances the efficiency of product storage and retrieval. Some other logistics applications for bar coding include coding of trucks and railway wagons, etc.

A bar code is an optical machine-readable representation of data. Originally, bar codes represented data in the widths (lines) and the spacing of parallel lines, and may be referred to as linear or 1D (1 dimensional) bar codes or symbologies. They also come in patterns of squares, dots, hexagons and other geometric patterns within images termed 2D (2 dimensional) matrix codes or symbologies. Although 2D systems use symbols other than bars, they are generally referred to as bar codes as well.

Barcodes can be read by optical scanners called bar code readers, or scanned from an image by special software. In Japan, most mobile phones have built-in scanning software for 2D codes, and similar software is becoming available on smart phone platforms.

Why Should You Consider Bar Coding?

Implementing a proper bar code system offers tremendous advantages to a company. The most compelling advantages of bar coding and automatic data collection are:

- **Accuracy:** Bar coding increases accuracy by reducing the likelihood of human errors from manual entry or miscommunication from misread or mislabelled items.

- **Ease-of-Use:** Bar codes are easy-to-use provided the appropriate hardware and software aspects are in place to maximize the process of automatic data collection. Obviously, pulling a trigger to enter in inventory is going to take much less effort and brain drain than it would to accurately account for all the inventory by hand.
- **Uniform Data Collection:** Diverse compliance standards and standardized bar code symbologies ensure that bar code information is captured and relayed in a fashion that is universally understood and accepted.
- **Timely Feedback:** Bar coding promotes timely feedback in that data is captured in real-time as it occurs: enabling decisions to be made from current information.
- **Improved Productivity:** Bar codes improve many activities that streamline work flows throughout a business.
- **Increased Profitability:** The increased efficiencies that bar coding promotes enables companies to save costs and substantially improve their bottom line.

6.7 RFID (RADIO-FREQUENCY IDENTIFICATION)

Radio-frequency Identification (RFID) is the use of an object (typically referred to as an RFID tag) applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves. Some tags can be read from several meters away and beyond the line of sight of the reader.

Most RFID tags contain at least two parts. One is an integrated circuit for storing and processing information, modulating and demodulating a radio-frequency (RF) signal, and other specialized functions. The second is an antenna for receiving and transmitting the signal.

European aircraft manufacturer Airbus received 'The Best RFID implementation' award in May 2008. The award was given for the successful implementation of RFID technology in its operations with an objective to improve the company's operational efficiency.

- Airbus, a leading aircraft manufacturer in the world, had a complex supply chain including multiple assembly plants and thousands of suppliers. The company followed a principle of continual improvement of its operations.
- Airbus' efforts to improve its operating efficiency included projects like Sup@irWorld and implementing RFID across its own as well its suppliers' operations.
- Airbus started using RFID in its operations way back in 1997. It applied this technology in its tool loan business where it used to lend certain tools to its customers that were required for maintenance of the aircraft.

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There are generally three types of RFID tags: active RFID tags, which contain a battery and can transmit signals autonomously, passive RFID tags, which have no battery and require an external source to provoke signal transmission, and Battery Assisted Passive (BAP) which require an external source to wake up but have significant higher forward link capability providing great read range.

RFID systems can be used just about anywhere, from clothing tags to missiles to pet tags to food – anywhere that a unique identification system is needed. The tag can carry information as simple as a pet owners name and address or the cleaning instruction on a sweater to as complex as instructions on how to assemble a car. Some auto manufacturers use RFID systems to move cars through an assembly line. At each successive stage of production, the RFID tag tells the computers what the next step of automated assembly is.

RFID is in use all around us. If you have ever chipped your pet with an ID tag, used EZPass through a toll booth, or paid for gas using SpeedPass, you've used RFID. In addition, RFID is increasingly used with biometric technologies for security.

Unlike ubiquitous UPC bar code technology, RFID technology does not require contact or line of sight for communication. RFID data can be read through the human body, clothing and non-metallic materials.

One of the key differences between RFID and bar code technology is RFID eliminates the need for line-of-sight reading that bar coding depends on. Also, RFID scanning can be done at greater distances than bar code scanning. High frequency RFID systems (850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz) offer transmission ranges of more than 90 feet, although wavelengths in the 2.4 GHz range are absorbed by water (the human body) and therefore has limitations.

RFID Components

- A basic RFID system consists of three components:
- An antenna or coil
- A transceiver (with decoder)
- A transponder (RF tag) electronically programmed with unique information

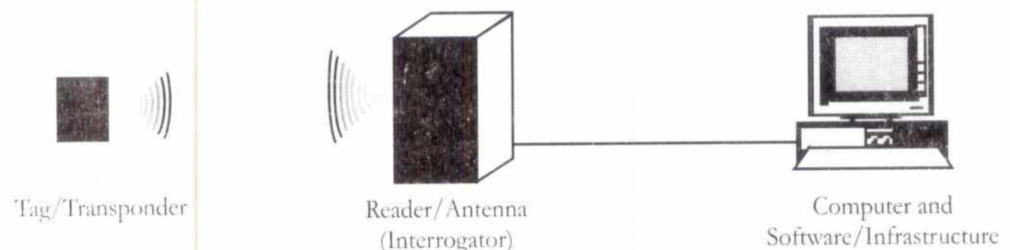


Fig. 6.3: RFID components

- The antenna emits radio signals to activate the tag and to read and write data to it.

Check Your Progress

1. What do you mean by ERP implementation?
2. Define warehouse management system.
3. What is the significance of bar codes?
4. Define RFID.

- The reader emits radio waves in ranges of anywhere from one inch to 100 feet or more, depending upon its power output and the radio frequency used. When an RFID tag passes through the electromagnetic zone, it detects the reader's activation signal.
- The reader decodes the data encoded in the tag's integrated circuit (silicon chip) and the data is passed to the host computer for processing.

The purpose of an RFID system is to enable data to be transmitted by a portable device, called a tag, which is read by an RFID reader and processed according to the needs of a particular application. The data transmitted by the tag may provide identification or location information, or specifics about the product tagged, such as price, colour, date of purchase, etc. RFID technology has been used by thousands of companies for a decade or more. RFID quickly gained attention because of its ability to track moving objects. As the technology is refined, more pervasive – and invasive – uses for RFID tags are in the works.

A typical RFID tag consists of a microchip attached to a radio antenna mounted on a substrate. The chip can store as much as 2 kilobytes of data.

To retrieve the data stored on an RFID tag, you need a reader. A typical reader is a device that has one or more antennas that emit radio waves and receive signals back from the tag. The reader then passes the information in digital form to a computer system.

Compared to traditional bar code-based systems, RFID-based data-capture systems have many advantages.

- **RFID tags:** Either active (with on-board battery) or passive
- **RFID readers:** To activate and read information on the tags
- **Communication technologies:** To move captured information
- **Information processing systems:** To store, compile, parse, interpret, and analyze transmitted information.

6.8 WAREHOUSE STRUCTURE

The warehouse structure can be decentralized or centralized depending upon the organisational requirements. In decentralized stores system, each section of the industry has a separate stores attached with it, whereas in centralized stores system, the main store is located centrally.

Advantages of centralisation of warehouse:

- Better supervision and control
- Requires less personnel to manage
- Better layout of stores
- Inventory checks are facilitated

- Optimum stores can be maintained
- Fewer obsolete items
- Better security arrangements can be made

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- Less risk of loss by fire or theft
- Less chances of production stoppages due to prompt availability of materials
- Reduced material handling and associated costs
- Convenient for user departments

Disadvantages of Centralized Warehouse Systems:

- Congestion in the storeroom
- Chances of misappropriation and thefts of particular items
- Possible delays in service to user departments
- Advantage of decentralization of stores

Disadvantages of Decentralization of Warehouse:

- Greater inventory carrying cost
- Difficulty in supervision and control

The warehouse structure should emphasize on centralized control and decentralized activity. The principal sections of a warehouse are generally:

- The receipt section
- The storage section
- The issue section

6.9 WAREHOUSE MASTER DATA

The material master record contains all information about the materials a company procures, manufactures, stores and ships. The data stored in the material masters is not only used by Warehouse Management (WM), but also by other application components, such as Inventory Management (IM), Production Planning (PP), Quality Management (QM) and Shipping (SD-SHP).

The integration of all information about a material into a single record eliminates redundancy and makes it possible to store material data for all relevant system components in a single database.

Note

This guide describes master data only from the viewpoint of WM. For detailed information about material master data, as well as instructions for creating, changing, or displaying material master records, refer to the MM—Managing Material Master Data documentation.

6.9.1 WM Material Master View

Since it is possible to use the materials management system without interfacing to warehouse management, other views may already exist when you create the WM view in the material master record. For example, data from other system components (such as purchasing, quality management, accounting and storage) may already exist in the material master.

To define warehousing data in the material master

1. Choose master data → Material → Create from the WM menu bar.

   To change data in the material master, choose Master data → Material → Change. The steps for changing data are basically the same as those described below. Using this function, you can overtype existing data in the material master record.
2. Enter a material number, industry sector code, and material type and choose Select view.
3. Choose Warehouse Management and any relevant additional views and choose Organisation levels.
4. In the organisation level window, you must enter a warehouse number as a minimum. You can also enter the plant and storage type. Enter a storage type only if you need to enter storage type data for fixed bins or special processing.
5. Choose data.If you selected only the warehouse management view, the system immediately displays the warehouse data screen.
6. As a minimum, you must enter a descriptive text about the material and the base unit of measure. If you entered a storage type on the organisational level screen, additional fields are displayed under the storage bin heading, such as the maximum and minimum quantity that can be stored in a bin and replenishment quantities.

   Linking the material master record to a hazardous material record

   These steps only apply if hazardous material management is active.
7. To link this material to a hazardous material record, enter the number or designator of the hazardous material in the hazardous material number field.
8. Save the data about the material to the data-base.

In the material status table, two fields are taken into consideration in warehouse management that make it possible to limit processes permitted for materials:

- **Transfer Requirement Instruction:** Based on the material status, the system issues a notification message when transfer requirements are created manually or via function modules. The system does not issue a notification when transfer requirements are created via the normal IM ↔ WM interface. Warnings

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are suppressed when the system creates transfer requirements via function modules.

- **Transfer Order Instruction:** Based on the material status, the system issues a warning message or an error message when transfer orders are created. When you confirm a transfer order, the system does not issue a notification. Warnings are suppressed when the system creates transfer orders via function modules.

6.9.2 Views in the Material Master Record

You maintain and display material master records using views. Just as data in the material master record is maintained for specific departments, such as quality assurance, sales or product planning, some of the data is used specifically by the warehouse management (WM) application.

For example, when you maintain material data from the viewpoint of warehouse management, the system displays only the data that is relevant for the storage of the material in the warehouse. General data that is relevant for more than one view (for example, the material's description, its weight, and its volume) appears in several views.

6.9.3 Organisation Level for Data

There are two organisational levels that can be defined for WM. In the WM view of the material master record, all the indicators and fields that are used for the entire warehouse number are entered at the warehouse number level. There is also a storage type level with all the indicators that apply to a single storage type but do not for the entire warehouse. If you enter a storage type for a material on the initial screen for the WM view, the system displays an additional section in which you can enter, for example, a fixed storage bin or a control quantity. These fields only apply to the storage type and not to the entire warehouse.

6.10 DEFINE WAREHOUSE STRUCTURE

When warehouse management is not in use, the lowest level of stock management is the storage location. In the Inventory Management (IM) application component, the storage location is defined as the location of physical deposits of stock within a plant. In this case, storage locations make up the various storage facilities (or areas) of a warehousing complex (for example, high rack storage, picking area or bulk storage). However, you can only manage the stock of a material in one storage bin. This bin is different from a WM storage bin in that it is entered into the material master record at the storage location level.

If you use IM without WM, you can assign one or more physical storage locations to each plant as shown in the following figure:

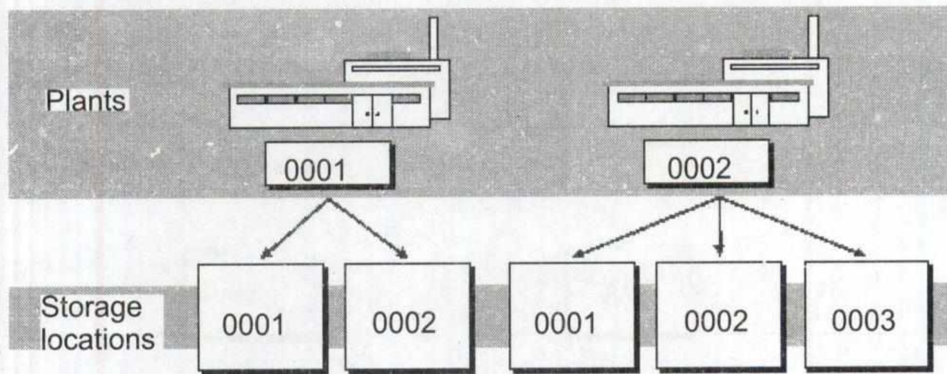


Fig. 6.4: Storage location for two plants

Note

In Figure 6.4, storage locations have been defined for two plants. The first plant has two storage locations: for example, 0001 for high rack storage and 0002 for bulk storage. Three storage locations have been assigned to the second plant: 0001 for high rack storage, 0002 for bulk storage and 0003 as a picking area.

When you use IM without WM, the system provides information about stock quantities at the storage location level as summarized values. It cannot provide information about individual pick slots, such as which materials are stored in specific storage bins.

Integration

The Warehouse Structure with WM

When you implement the Warehouse Management (WM) application in a plant, you assign the warehouse number to one or more MM storage locations and the individual storage areas (for example, high rack storage and so on) are assigned as separate storage types under the warehouse number (complex). Although possible, the definition of several storage locations for one plant is only necessary for special situations. One situation would be when there are additional warehouses (storage areas) within a plant that are not managed using WM.

When you install WM, although data about the stock quantities is managed at the storage location level in IM, you manage information about the actual storage bin location of the material in the warehouse in WM.

To link the information at the storage location level to information from the storage bin, you assign the IM storage location to a warehouse number in WM as illustrated in the following figure:

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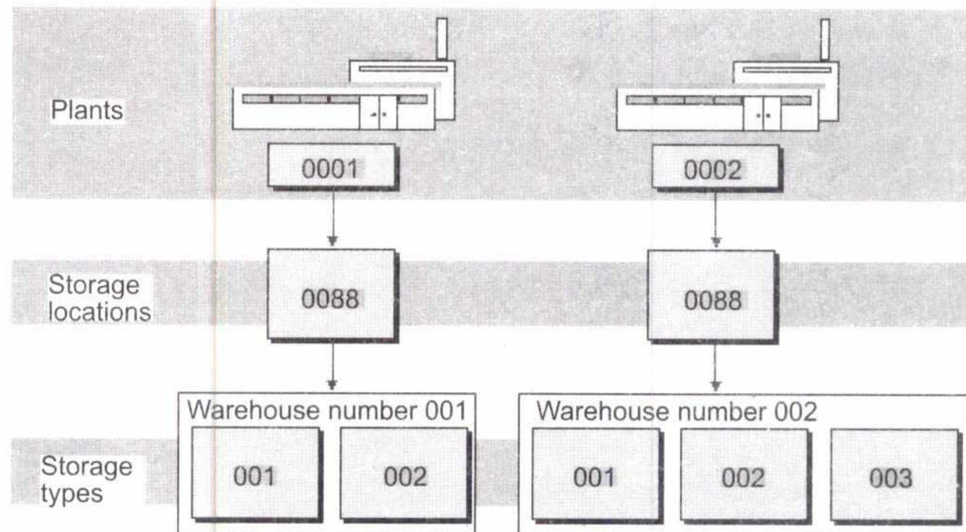


Fig. 6.5: Two plants that manage a storage location using WM

This figure depicts two plants that each manage a storage location using WM. Storage location 0088 in the first plant is assigned to warehouse number 001. Two storage types are assigned to warehouse 001. Storage location 0088 in the second plant is assigned to warehouse number 002. In warehouse complex 002 there are three storage types. In WM you define storage bins for each of the storage types. WM then manages data about all of the materials stored in each of the storage bins in the entire warehouse.

You can also manage stock for several plants in the same warehouse at the same time. In this case, you would assign the storage locations for these plants to the same warehouse number as shown below.

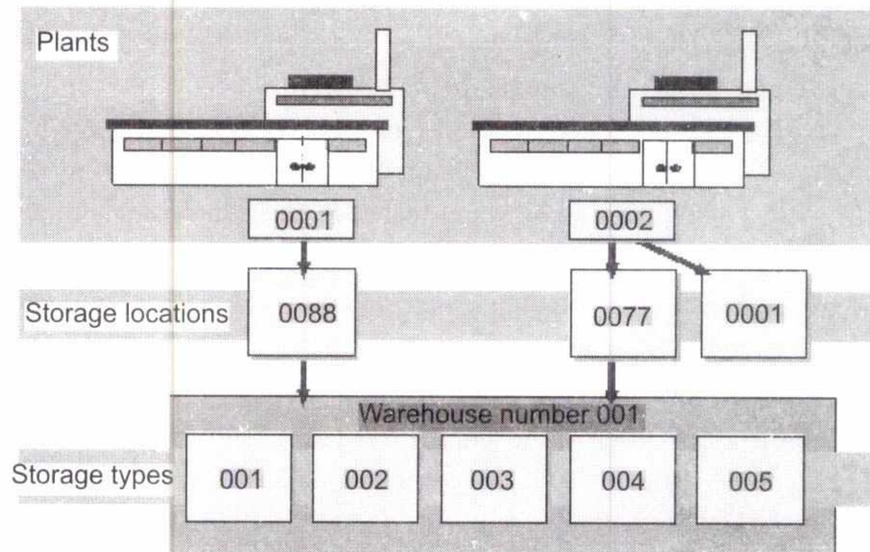


Fig. 6.6: Assigning storage locations to the same warehouse number

Although it is generally advantageous to assign one plant/storage location combination to one warehouse number, you can also assign more than one storage location per plant to a single warehouse number.

Setting up the Connection Between IM and WM

You set up the link between a plant storage location in IM and a warehouse number in WM under Enterprise Structure → Assignment → Materials Management in the Enterprise Management IMG.

The system uses the links that you create to the Inventory Management (IM) application component to ensure that certain processes in the Quality Management (QM) component, the Product Planning (PP) component, and the Sales and Distribution (SD) component are carried out in WM for the appropriate warehouse number.

Features

What does the warehouse structure look like in WM?

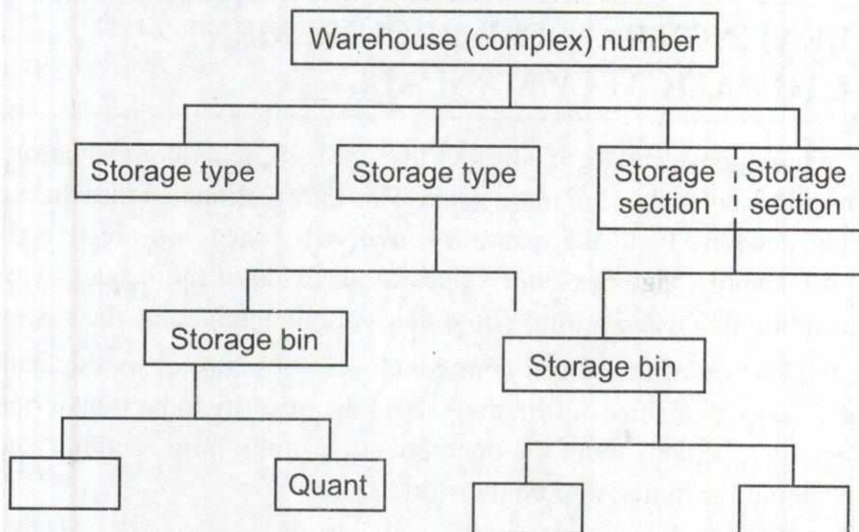


Fig. 6.7: The Warehouse Structure

The warehouse structure in Warehouse Management is hierarchical and consists of the following elements:

The Warehouse Number

You can define an entire physical warehousing complex in WM using a single warehouse number.

The Storage Type

Each of the storage facilities or areas that make up the warehousing complex can be defined as a type of storage area or "storage type" by its spatial, technical and organisational factors.

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Each storage type is divided into storage sections. A storage section generally includes all bins that have certain characteristics in common, such as bins for "fast-moving items" near a goods issue area. You can set your own criteria for grouping bins into a storage section.

The Storage Bin

Each storage type and section consists of several storage spaces or slots. These are called storage bins in WM and are the smallest addressable unit of space in a storage type. Storage bins are identified by coordinates that refer to the exact position where goods can be stored in the warehouse.

The Quant

The quant is used to separate goods in the storage bin based on their differing characteristics. You can create this structure in WM using the Warehouse Management Implementation Guide (IMG) to assimilate the layout of any physical warehouse.

6.11 CREATING TRANSFER REQUIREMENT AUTOMATICALLY/MANUALLY

A transfer requirement consists of a header that contains general information about the entire requirement and one or more items. This information includes the material that is to be transferred and the quantities involved. When you create a transfer requirement manually, you can enter values in all fields of the header except the fields in the additional data section. These fields are maintained by the system.

The first section of the screen item contains information from the header. In the second section, you enter information about the quantity to be transferred. The system maintains the data about the open quantity. In the third section, you enter information about the material to be transferred.

6.11.1 Creating a TO for a Transfer Requirement Manually

There are many factors that come into play when creating transfer orders manually from a transfer requirement and each individual procedure cannot be described in the scope of this documentation. How you process a transfer requirement varies depending upon the number of transfer requirement items and whether the stock movement involves a putaway or a pick. The following procedures provide a detailed description of some of these options.

Put-away for a Transfer Requirement with One Item

1. Choose TransOrder → Create → For transfer requirement from the WM menu bar.

2. On the initial screen, enter the warehouse number and the transfer requirement (TR) number. You can also enter optional control information on the initial screen that influences the way the system processes the TR.

   Choose ENTER

3. You have several options on the preparation screen for put-aways. You can

   – Enter palletization information

   – Process the TR in the background (*Transfer order → Post*)

   – Enter the destination bin manually

   – Add the material to existing stock (*Add to existing stock*)

   You can enter the destination bin yourself on the preparation screen.

   If you choose *Stock placement background*, the system selects a destination storage bin for you.

   If you decide to process the transfer requirement in the foreground, the system goes to the item screen and suggests a destination storage bin. In this mode, you can change the destination bin manually.

   Adding Materials to Existing Stock

   If you choose *Add to existing stock*, the system displays two tabs. The first tab contains a list of bins with the existing stock to which more can be added. The second tab contains a list of bins with the material that cannot be added to (for example, the bin is blocked for putaway). In the first tab, you can select bins for calculation or enter the open quantity to be added to the existing stock.

   This screen also features an *Available capacity* column which displays the actual available capacity of the each storage bin using the unit of measure displayed in the *Plcmnt qty* (putaway quantity) field at the top of the screen. The *Available capacity* field is blank if the capacity check for the storage bin is not active. The system does not display storage bins that are full with the existing stock in this list.

   For example, if you mark the bins and choose the *Calculate* button, the system adds the open quantity to the *To be added* fields from top to bottom based on the available capacity for the bins.

   Caution

   If the quantity shown in the Available capacity column is displayed as a decimal, you may need to adjust the quantity calculated by the system in the To be added field manually. For example, if the open quantity to be added is 200 pieces and the available capacity is shown as 123,648 pieces, you need to correct the quantity in the To be added column to 123 pieces.

4. To post the data to the database, choose Transfer order → Post.

   The system displays a message with the newly created transfer order number.

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Put-away for a Transfer Requirement with More than One Item

1. Choose *TransOrder →Create →For transfer requirement* from the WM menu bar.
2. Enter the *Warehouse number* and the *Transfer requirement* (TR) number on the initial screen.

   If you want to create the transfer order immediately for all of the TR items, enter **d** in the *foreground/background* field for processing in the background and choose ENTER .

   If you want to create the transfer order in the foreground, enter **h** in this field and choose ENTER. (Depending on the system configuration, you can leave the *foreground/background* field blank.)

   When you process the TR in the foreground, the system displays three tabs:

   – Active work list

   – Inactive items

   – Processed items

   Note

   In the *Control* section on the initial screen, if you deselect the *Select items* field, the system sends all TO items to the *Inactive items* tab. You can selectively activate them (send them to the active work list) by marking them and choosing the *Active* button.
3. From this screen, you can:

   – Branch to the palletization screen

   – Create a storage unit (SU)

   – Add materials to a storage unit

   – Immediately generate TO items for items in the *Active work list*

   The *Active work list* contains items for processing. The system processes all items for which there is a value in the *Selected quantity* column regardless of whether they are marked or not.

   You can accept the default quantities in the *Selected quantity* column or change them.

   Note

   In the active work list, the column *Open quantity* lists the transfer requirement (TR) quantities that are unprocessed. This applies to both putaway and picking. If you reduce a quantity (enter a smaller quantity) in the *Selected quantity* field, the system adjusts the open quantity accordingly. This way, you can reduce (process) selected quantities without losing the information as to which quantities of TR have not yet been processed.

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The system will not process items that are listed in the *Inactive items* tab.

4. To create TO items in the system, choose *Generate TO items*.

   When the system has created the last TO item from the active work list, it displays them in the *Processed items* tab.

   The *Processed items* tab lists all TO items that have been processed internally. However, these are not fully processed until you have posted them to the database. Therefore, you can still "back up" to the initial screen and start again to change the values for each item.

5. To complete the transaction, choose *Transfer order* → *Post.*

Creating a TO for a Transfer Requirement for Stock Removal

When you create a transfer order for a TR for picking, the procedure is basically the same as for a put-away.

Preparation Screen for Picking

The preparation screen features configurable table controls and push buttons at the bottom of the screen that allow you to select and deselect all items and to delete the entries in the open fields.

Note

When you mark items and choose the *Delete* (trash can) button, this does not delete the item from the system. It only deletes the entries in the fields that are marked so that you can reenter or correct them.

The button *All storage types* in the *Storage type search* section of the preparation screen displays a dialog box where you can enter up to 30 storage types for the search sequence. The system searches for storage types horizontally, from left to right on the first line, then the second line and so on.

Stock List

If you choose *Stock list,* the system displays two tabs. The first tab contains a list of stock that is available for picking. The second tab contains stock that cannot be picked, such as blocked stock.

You can enter the quantities in the *Selected quantity* column manually or you can allow the system to calculate these quantities. For storage bins that are marked in the first tab (*Stock that can be removed*), when you select the *Calculate* button, the system calculates entries on the screen from **top to bottom** and selects the needed quantity from the available stock.

Sort buttons at the bottom of the screen allow you to sort available stock by using criteria in the column headers.

Note

If you want to empty several bins that have small quantities in them, this feature can be very useful. For example, click the left mouse button on the column

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header *Avail.stock* to select the entire column that lists available stock. To sort this column so that the smallest available quantity appears at the top of the list, choose the *Sort in ascending order* (arrow up) button. To select the bins with the smallest quantities first for the stock removal, choose the *Select all* button and then the *Calculate selected quantity* button. The system will copy the quantities from the bins "up to" the total quantity needed into the *Selected quantity* column.

The system will also accept less than the open quantity, but informs you that the requested amount is not complete and asks if the quantity of created items is sufficient.

To complete the process, choose *Transfer order → Post.*

6.11.2 Automatic TO Creation for Transfer Requirements

You can set up the Warehouse Management System to create transfer orders automatically as a background process. You set up the system to carry out this process by setting an indicator in each movement type separately. When you create a transfer requirement, the system copies this indicator into the transfer requirement header.

To activate the automatic creation of transfer orders for these transfer requirements you must start the report RLAUTA10 as a batch job. For this process you define a variant for each different indicator. This makes it possible for you to define different starting times and time spans to repeat each task periodically.

To create transfer orders automatically, three processes are available:

1. The system creates a transfer order for each transfer requirement
2. The system creates transfer orders only for transfer requirements that meet certain criteria (for example, date or time). You enter these criteria individually into a user exit.
3. Using criteria as described in point 2, you can also set up the system to assign a reference number to combine the transfer requirements for multiple processing. The assignment of the reference number can take place separately in a user exit.

Creating Transfer Orders for Posting Change Notices

You can create transfer orders automatically for certain classes of posting change notices. Using the indicator automatic transfer order creation, you can select certain movement types for this processing. To activate automatic transfer order creation for these posting change notices, you need to plan the report RLAUTA11 as a batch job. Here you define a separate variant for the different indicators. This way, different starting times and repetition cycles can be defined for the different indicators.

When the transfer orders are created, you can activate two processing types:

- A transfer order is created for each posting change notice.

- A transfer order is created only for posting change notices that fulfill certain criteria (for example, date, time). The criteria can be defined individually using an SAP customer exit.
- If needed, you can generate a log to be sent to the inbox of a selected user.

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Setting up the System to Create Transfer Orders Automatically

For instructions on how to set up automatic TO creation for transfer requirements and posting change notices, see the Warehouse Management IMG documentation under activities → Transfers → Set up autom. TO creation for TRs/posting change notices.

Immediate TO Creation for IM Posting

Whether the system creates a transfer order immediately for a material document posting in IM is based on several factors. These are illustrated in the figure below:

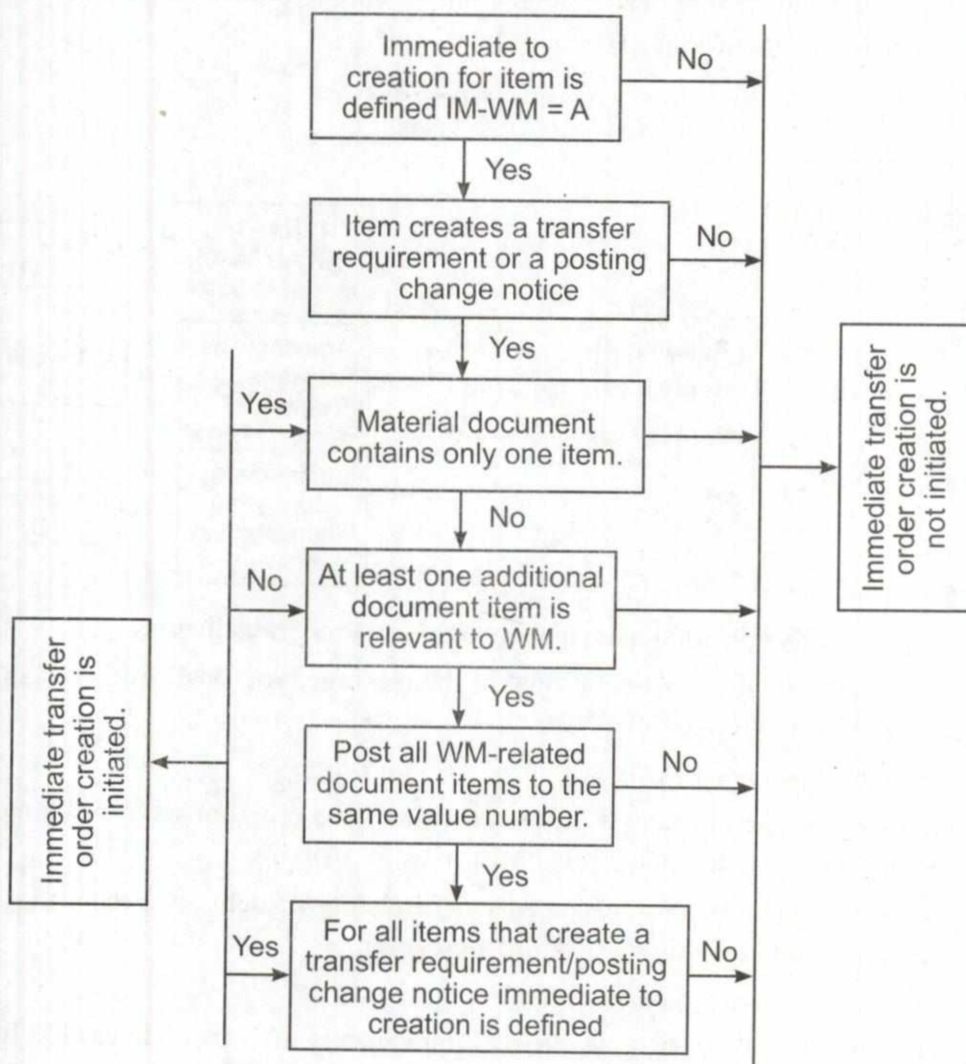


Fig. 6.8: To creation for IM posting

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Note

If a transfer requirement is defined for immediate transfer order creation, the system selects the field immediate TO creation in the header. If the system does not create a transfer order immediately, you should activate the mail control. This way, you can determine whether the problem lies in the actual TO creation (a mail message is generated) or in the way the system processes the material document as shown in the above graphic.

Automatic/Immediate Transfer Order Creation for Deliveries

For the interface between SD shipping and WM, you can also set up immediate or automatic transfer order creation for deliveries.

This process is controlled by the message control function in the SD Shipping component. The condition technique can be used to initiate message type "WMTA" when the delivery is created. The prerequisite for this is that at least one item of the delivery is relevant to WM. The combination "Shipping point / Delivery type" is used to determine the message type.

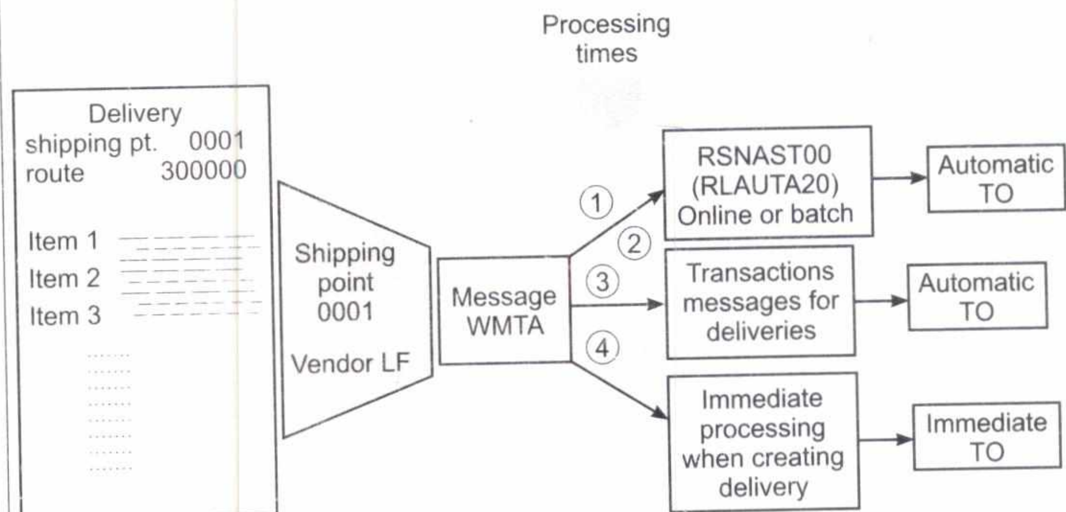


Fig. 6.9: Automatic transfer order creation for deliveries

Depending on the processing time of the message type WMTA, there can be different processing types:

- *Time 1 - 3 (processing later)*

  In this case, the message is processed either via a program set in batch mode or manually via the transaction "Messages for delivery".

  Since this processing is executed independently of delivery generation, we refer to it as automatic transfer order creation.

- *Time 4 (processing immediately)*

  Here message processing is initiated immediately after the delivery has been created. Therefore, we call this immediate transfer order creation.

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If you want the system to generate transfer orders in the background without any additional activity necessary by the user, we recommend that you use processing times "1" or "2". You can then plan to periodically execute the report RSNAST00 (Selection Program for Issuing Output) with a corresponding repetition time for the message type WMTA.

This variant of processing transfer orders in the system provides significant advantages in system performance in comparison to processing time "4" and is by far the preferred method to use for this activity.

If you choose an appropriately small repetition time period when you set up the system to use report RSNAST00, the time required to create transfer orders is nearly the same as when using time period "4" for immediate transfer order generation.

To maintain the message determination for deliveries, see Sales and Distribution → Basic Functions → Output Control → Output Determination → Output Determination Using the Condition Technique → Maintain Output Determination for Deliveries → Maintain Condition Tables in the SD Shipping IMG documentation.

6.12 CREATING TRANSFER REQUIREMENTS FOR STORAGE

To initiate the supply of materials to storage bins at production supply areas, you must create transfer requirements that are based on production orders or on the need for materials in the production bins.

Transfer requirements are created based on the material staging types listed below:

Pick Parts

To create transfer requirements manually for material staging based on a production order, choose Transfer Requirement → Create → Production supply → For production order from the WM menu bar or Logistics → Production → Production control and then Environment → WM mat.provision → For order from the SAP main menu.

This material staging method using a separate transaction is more flexible than creating transfer requirements from the production order because it allows you to process smaller quantities and percentages of a production order based on individual workstation requirements. To use this method, you need to deactivate automatic staging (see Automatic Staging for WM.)

Crate Parts

To create transfer requirements for crate parts, choose Tran Rqmnt → Create → Production supply → For crate part from the WM menu bar or Logistics → Production

→ Production control and then Environment ® WM mat.provision → For crate part from the SAP main menu.

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Release Order Parts

To create transfer requirements for release order parts, choose TransRqmnt → Create → Production supply → For release order part from the WM menu bar or Logistics → Production → Production control and then Environment → WM mat.provision → For release part from the SAP main menu.

When creating transfer requirements for release order parts, you can display all the production orders that use the material requested in the selected supply area.

How you process subsequent screens for all three methods of material staging is generally self-explanatory and is described in the online documentation for individual data fields.

Units of Measure

It is possible for you to select a specific unit of measure for the supply of pick parts and release order parts to production. You specify the unit of measure while carrying out material staging.

When you create transfer requirements for production supply in WM (or in PP), you can select the unit of measure to be used for displaying the material staging list. On the material staging overview screen you choose Edit → Unit of Measure. The system displays a dialog box in which you can enter the desired unit of measure. When you select one of the options, the system displays the quantity fields in the material staging list to match your selection. Transfer requirements that are created for the material staging list are then generated using the selected unit of measure.

The unit of measure you choose is stored in the Parameter ID "LMB", so that the next time you carry out the material staging task, the unit of measure you selected previously is automatically suggested as a default.

Check Your Progress

Fill in the Blanks

5. The .... is used to separate goods in the storage bin based on their differing characteristics.
6. A .... consists of a header that contains general information about the entire requirement and one or more items.
7. A .... section generally includes all bins that have certain characteristics in common, such as bins for "fast-moving items" near a goods issue area.

Setting a Default Unit of Measure for Material Staging

To set a system default for the unit of measure used in staging materials, choose Tools → Administration → Maintain users → Users → Goto → Parameters and enter one of the following parameter values for Parameter ID "LMB":

- Blank = base unit of measure
- 1 = unit of issue
- 2 = WM unit of measure

Note

When you create the control cycle record for crate parts, you can define any unit of measure for container quantities. When you stage materials for crate parts, the system then uses the unit of measure defined in the control cycle record.

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Case Study: Nestle's Growth Strategy

Nestle is one of the oldest of all multinational businesses. The company was founded in Switzerland in 1866 by Heinrich Nestle, who established Nestle to distribute "milk food," a type of infant food he had invented that was made from powdered milk, baked food, and sugar. From its very early days, the company looked to other countries for growth opportunities, establishing its first foreign offices in London in 1868. In 1905, the company merged with the Anglo-Swiss Condensed Milk, thereby broadening the company's product line to include both condensed milk and infant formulas. Forced by Switzerland's small size to look outside' its borders for growth opportunities, Nestle established condensed milk and infant food processing plants in the United States and Britain in the late 19th century and in Australia, South America, Africa, and Asia in the first three decades of the 20th century. In 1929, Nestle moved into the chocolate business when it acquired a Swiss chocolate maker. This was followed in 1938 by the development of Nestle's most revolutionary product, Nescafe, the world's first soluble coffee drink. After World War 11, Nestle continued to expand into other areas of the food business, primarily through a series of acquisitions that included Maggi (1947), Cross & Blackwell (1960), Findus (1962), Libby's (1970), Stouffer's (1973), C·‧nation (1985), Rowntree (1988), and Perrier (1992). By the late 1990s, Nestle had 500 factories in 76 countries and sold its products in a staggering 193 nations-almost every country in the world. In 1998, the company generated sales of close to SWF 72 billion ($51 billion), only 1 percent of which occurred in its home country. Similarly, only 3 percent of its- 210,000 employees were located in Switzerland. Nestle was the world's biggest maker of infant formula, powdered milk, chocolates, instant coffee, soups, and mineral waters. It was number two in ice cream, breakfast cereals, and pet food. Roughly 38 percent of its food sales were made in Europe, 32 percent in the Americas, and 20 percent in Africa and Asia.



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Management Structure

Nestlé is a decentralized organization. Responsibility for operating decisions is pushed down to local units, which typically enjoy a high degree of autonomy with regard to decisions involving pricing, distribution, marketing, human resources, and so on. At the same time, the company is organized into seven worldwide strategic business units (SBUs) that have responsibility for high-level strategic decisions and business development. For example, a strategic business unit focuses on coffee and beverages. Another one focuses on confectionery and ice cream. These SBUs engage in overall strategy development, including acquisitions and market entry strategy. In recent years, two-thirds of Nestlé's growth has come from acquisitions, so this is a critical function. Running in parallel to this structure is a regional organization that divides the world into five major geographical zones, such as Europe, North America and Asia. The regional organizations assist in the overall strategy development process and are responsible for developing regional strategies (an example would be Nestlé's strategy in the Middle East, which was discussed earlier). Neither the SBU nor regional managers, however, get involved in local operating or strategic decisions on anything other than an exceptional basis.

Although Nestlé makes intensive use of local managers to knit its diverse worldwide operations together, the company relies on its "expatriate army." This consists of about 700 managers who spend the bulk of their careers on foreign assignments, moving from one country to the next. Selected primarily on the basis of their ability, drive and willingness to live a quasi-nomadic lifestyle, these individuals often work in half-a-dozen natiosn during their careers. Nestlé also uses management development programs as a strategic tool for creating an esprit de corps among managers. At Rive-Reine, the company's international training center in Switzerland, the company brings together, managers from around the world, at different stages in their careers, for specially targetted development programs of two to three weeks' duration. The objective of these programs is to give the managers a better understanding of Nestlé's culture and strategy, and to give them access to the company's top management.

The research and development operation has a special place within Nestlé, which is not surprising for a company that was established to commercialize innovative foodstuffs. The R&D function comprises 18 different groups that operate in 11 countries throughout the world. Nestlé spends approximately 1 percent of its annual sales revenue on R&D and has 3,100 employees dedicated to the function. Around 70 percent of the R&D budget is spent on development initiatives. These initiatives focus on developing products and processes that fulfill market needs, as identified by the SBUs, in concert with regional and local managers. For example, Nestlé instant noodle products were originally developed

by the R&D group in response to the perceived needs of local operating companies through the Asian region. The company also has longer-term development projects that focus on developing new technological platforms, such as non-animal protein sources or agricultural biotechnology products.

A Growth Strategy for the 21st Century

Despite its undisputed success, Nestlé realized by the early 1990s, that it faced significant challenges in maintaining its growth rate. The large Western European and North American markets were mature. In several countries, population growth had stagnated and in some, there had been a small decline in food consumption. The retail environment in many Western nations had become increasingly challenging and the balance of power was shifting away from the large-scale manufacturers of branded foods and beverages, and toward nationwide supermarket and discount chains. Increasingly, retailers found themselves in the unfamiliar position of playing off against each other – manufacturers of branded foods, thus bargaining down prices. Particularly in Europe, this trend was enhanced by the successful introduction of private-label brands by several of Europe's leading supermarket chains. The results included increased price competition in several key segments of the food and beverage market, such as cereals, coffee and soft drinks.

At Nestlé, one response has been to look toward emerging markets in Eastern Europe, Asia and Latin America for growth possibilities. The logic is simple and obvious – a combination of economic and population growth, when coupled with the widespread adoption of market-oriented economic policies by the governments of many developing nations, makes for attractive business opportunities. Many of these countries are still relatively poor, but their economies are growing rapidly. For example, if current economic growth forecasts occur, by 2010, there will be 700 million people in China and India that have income levels approaching those of Spain in the mid-1990s. As income levels rise, it is increasingly likely that consumers in these nations will start to substitute branded food products for basic foodstuffs, creating a large market opportunity for companies such as Nestlé.

In general, the company's strategy had been to enter emerging markets early – before competitors – and build a substantial position by selling basic food items that appeal to the local population base, such as infant formula, condensed milk, noodles and tofu. By narrowing its initial market focus to just a handful of strategic brands, Nestlé claims it can simplify life, reduce risk, and concentrate its marketing resources and managerial effort on a limited number of key niches. The goal is to build a commanding market position in each of these niches. By pursuing such a strategy, Nestlé has taken as much as 85 percent of the market for instant coffee in Mexico, 66 percent of the market for powdered milk in the Philippines, and 70 percent of the markets for soups in Chile. As income levels rise, the company progressively moves out from these niches, introducing more upscale items, such as mineral water, chocolate, cookies, and prepared foodstuffs.

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Although the company is known worldwide for several key brands, such as Nescafe, it uses local brands in many markets. The company owns 8,500 brands, but only 750 of them are registered in more than one country, and only 80 are registered in more than 10 countries. While the company will use the same "global brands" in multiple developed markets, in the developing world it focuses on trying to optimize ingredients and processing technology to local conditions and then using a brand name that resonates locally. Customization rather than globalization is the key to the company's strategy in emerging markets.

Executing the Strategy

Successful execution of the strategy for developing markets requires a degree of flexibility, an ability to adapt in often unforeseen ways to local conditions, and a long-term perspective that puts building a sustainable business before short-term profitability. In Nigeria, for example, a crumbling road system, aging trucks, and the danger of violence forced the company to re-think its traditional distribution methods. Instead of operating a central warehouse, as is its preference in most nations, the country. For safety reasons, trucks carrying Nestlé goods are allowed to travel only during the day and frequently under-armed guard. Marketing also poses challenges in Nigeria. With little opportunity for typical Western-style advertising on television of billboards, the company hired local singers to go to towns and villages offering a mix of entertainment and product demonstrations.

China provides another interesting example of local adaptation and long-term focus. After 13 years of talks, Nestlé was formally invited into China in 1987, by the Government of Heilongjiang province. Nestlé opened a plant to produce powdered milk and infant formula there in 1990, but quickly realized that the local rail and road infrastructure was inadequate and inhibited the collection of milk and delivery of finished products. Rather than make do with the local infrastructure, Nestlé embarked on an ambitious plan to establish its own distribution network, known as milk roads, between 27 villages in the region and factory collection points, called chilling centres. Farmers brought their milk – often on bicycles or carts – to the centres where it was weighed and analysed. Unlike the government, Nestlé paid the farmers promptly. Suddenly the farmers had an incentive to produce milk and many bought a second cow, increasing the cow population in the district by 3,000 to 9,000 in 18 months. Area managers then organized a delivery system that used dedicated vans to deliver the milk to Nestlé's factory.

Although at first glance this might seem to be a very costly solution, Nestlé calculated that the long-term benefits would be substantial. Nestlé's strategy is similar to that undertaken by many European and American companies during the first waves of industrialization in those countries. Companies often had to invest in infrastructure that we now take for granted to get production off the ground. Once the infrastructure was in place, in China, Nestlé's production took off. In 1990, 316 tons of powdered milk and infant formula were produced. By 1994,

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output exceeded 10,000 tons and the company decided to triple capacity. Based on this experience, Nestlé decided to build another two powdered milk factories in China and was aiming to generate sales of $700 million by 2000.

Nestlé is pursuing a similar long-term bet in the Middle East, an area in which most multinational food companies have little presence. Collectively, the Middle East accounts for only about 2 percent of Nestlé's worldwide sales and the individual markets are very small. However, Nestlé's long-term strategy is based on the assumption that regional conflicts will subside and intra-regional trade will expand as trade barriers between countries in the region come down. Once that happens, Nestlé's factories in the Middle East should be able to sell throughout the region, thereby realizing scale economies. In anticipation of this development, Nestlé has established a network of factories in five countries, in the hope that each will, someday, supply the entire region with different products. The company, currently makes ice-cream in Dubai, soups and cereals in Saudi Arabia, yogurt and bouillon in Egypt, chocolate in Turkey, and ketchup and instant noodles in Syria. For the present, Nestlé can survive in these markets by using local materials and focusing on local demand. The Syrian factory, for example, relies on products that use tomatoes, a major local agricultural product. Syria also produces wheat, which is the main ingredient in instant noodles. Even if trade barriers don't come down soon, Nestlé has indicated it will remain committed to the region. By using local inputs and focussing on local consumer needs, it has earned a good rate of return in the region, even though the individual markets are small.

Despite its successes in places such as China and parts of the Middle East, not all of Nestlé's moves have worked out so well. Like several other Western companies, Nestlé has had its problems in Japan, where a failure to adapt its coffee brand to local conditions meant the loss of a significant market opportunity to another Western company, Coca Cola. For years, Nestlé's instant coffee brand was the dominant coffee product in Japan. In the 1960s, cold canned coffee (which can be purchased from soda vending machines) started to gain a following in Japan. Nestlé dismissed the product as just a coffee-flavoured drink rather than the real thing and declined to enter the market. Nestlé's local partner at the time, Kirin Beer, was so incensed at Nestlé's refusal to enter the canned coffee market that it broke off its relationship with the company. In contrast, Coca Cola entered the market with Georgia, a product developed specifically for this segment of the Japanese market. By leveraging its existing distribution channel, Coca Cola captured a 40 percent share of the $4 billion a year, market for canned coffee in Japan. Nestlé, which failed to enter the market until the 1980s, has only a 4 percent share.

While Nestlé has built businesses from the ground up, in many emerging markets, such as Nigeria and China, in others it will purchase local companies if suitable candidates can be found. The company pursued such a strategy in Poland, which it entered in 1994, by purchasing Goplana, the country's second

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largest chocolate manufacturer. With the collapse of communism and the opening of the Polish market, income levels in Poland have started to rise and so has chocolate consumption. Once a scarce item, the market grew by 8 percent a year, throughout the 1990s. To take advantage of this opportunity, Nestlé has pursued a strategy of evolution, rather than revolution. It has kept the top management of the company staffed with locals – as it does in most of its operations around the world – and carefully adjusted Goplana's product line to better match local opportunities. At the same time, it has pumped money into Goplana's marketing, which has enabled the unit to gain share from several other chocolate makers in the country. Still, competition in the market is intense. Eight companies, including several foreign-owned enterprises, such as the market leader, Wedel, which is owned by PepsiCo, are vying for market share, and this has depressed prices and profit margins, despite the healthy volume growth.

Discussions:

- Does it make sense for Nestle to focus its growth efforts on emerging markets? Why?
- What is the company's strategy with regard to business development in emerging markets? Does this strategy make sense? From an organizational perspective, what is required for this strategy to work effectively?
- Through your own research on NESTLE, identify appropriate performance indicators. Once you have gathered relevant data on these, undertake a performance analysis of the company over the last five years. What does the analysis tell you about the success or otherwise of the strategy adopted by the company?
- How would you describe Nestle's strategic posture at the corporate level; is it pursuing a global strategy, a multidomestic strategy an international strategy or a transnational strategy?
- Does this overall strategic posture make sense given the markets and countries that Nestle participates in? Why?
- Is Nestle's management structure and philosophy aligned with its overall strategic posture?

Source: *Scribd.com*

6.13 SUMMARY

- ERP implementation is a special event since it involves the entire organisation over a period of time. It brings together different functionality, people, procedures, and ideologies, and leads to sweeping changes throughout the organisation.

- A Warehouse management system is the combination of hardware computing devices, mobile and desktop software and peripheral interfaces for utilising in organising all aspects of a warehouse and stockyard.
- Bar codes are used to identify the contents of package and provide information on the product as well as the package.
- Radio-frequency Identification (RFID) is the use of an object (typically referred to as an RFID tag) applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves.
- The warehouse structure can be decentralized or centralized depending upon the organisational requirements. In decentralized stores system, each section of the industry has a separate stores attached with it, whereas in centralized stores system, the main store is located centrally.
- The material master record contains all information about the materials a company procures, manufactures, stores and ships.
- There are two organisational levels that can be defined for WM. In the WM view of the material master record, all the indicators and fields that are used for the entire warehouse number are entered at the warehouse number level.
- A transfer requirement consists of a header that contains general information about the entire requirement and one or more items. This information includes the material that is to be transferred and the quantities involved.

6.14 KEY TERMS

- **Warehouse Management System:** A Warehouse management system is the combination of hardware computing devices, mobile and desktop software and peripheral interfaces for utilising in organising all aspects of a warehouse and stockyard.
- **Bar Codes:** Bar codes are used to identify the contents of package and provide information on the product as well as the package.
- **Radio-Frequency Identification (RFID):** Radio-Frequency Identification (RFID) is the use of an object (typically referred to as an RFID tag) applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves.
- **Material Master Record:** The material master record contains all information about the materials a company procures, manufactures, stores and ships.

6.15 ANSWERS TO 'CHECK YOUR PROGRESS'

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1. ERP implementation is a special event since it involves the entire organisation over a period of time. It brings together different functionality, people, procedures, and ideologies, and leads to sweeping changes throughout the organisation.
2. A Warehouse management system is the combination of hardware computing devices, mobile and desktop software and peripheral interfaces for utilising in organising all aspects of a warehouse and stockyard.
3. Bar codes are used to identify the contents of package and provide information on the product as well as the package.
4. Radio-frequency Identification (RFID) is the use of an object (typically referred to as an RFID tag) applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves. Some tags can be read from several meters away and beyond the line of sight of the reader.
5. Quant
6. Transfer requirement
7. Storage

6.16 QUESTIONS AND EXERCISES

Short Answer Questions

1. Define warehouse documentation.
2. Write a short note on ERP and warehouse master data.
3. Briefly discuss the importance of bar coding.
4. What are the key elements of warehouse structure?

Long Answer Questions

1. Discuss the meaning and nature of WMS.
2. Define RFID. What are the key components of RFID?
3. Write a note on ERP and warehouse structure.
4. Define warehouse structure. What are the key elements of warehouse structure?
5. How does one create transfer requirements automatically/manually?

MODEL QUESTION PAPER

DISTANCE EDUCATION

MBA Degree Examinations

Fourth Semester

Warehousing Management

NOTES

Time: Three hours *Maximum: 100 Marks*

PART A **(5 × 8 = 40 Marks)**

Answer any FIVE Questions

1. Explain the meaning of warehousing. Why warehousing is necessary?
2. What are the characteristics of an ideal warehouse?
3. Define warehouse layout. State its relevance and importance.
4. Briefly explain the role of logistics in warehouse.
5. Write a short note on material storage system.
6. Define industrial shelving. Explain its significance.
7. What are the key functions of inventory management?
8. Write a short note on ERP and RFID.

PART B **(4 × 15 = 60 Marks)**

Answer any FOUR Questions

9. Define warehousing. What are the key utility and advantages of warehousing?
10. What are the principles and facilities of warehouse layout?
11. Discuss the management of material turn in a warehouse.
12. What are the different types of metrics to measure the warehouse efficiency?
13. What are the different types of loading and unloading equipments?
14. Define inventory management. Analyze the key need and functions of inventory management?
15. Define warehouse structure. Explain the key elements of warehouse structure?

MBA (PRODUCTION AND OPERATIONS MANAGEMENT)
PAPER- 4.3

WAREHOUSING MANAGEMENT



ALAGAPPA UNIVERSITY

**(A State University Established by the Government of Tamilnadu-
Reaccredited with 'A' Grade by NAAC)
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